INTEGRATED RENEWABLE RESOURCE MANAGEMENT FOR U.S. INSULAR AREAS

Volume II--Contract Papers

Part A: The Setting for Resource Development

1. Tropical Island Ecosystems and Protection Technologies to Sustain Renewable Resources in U.S.-Affiliated Islands
   (Arthur L. Dahl)

2. Case Studies of the Impacts of Introduced Animal Species on Renewable Resources in the U.S.-Affiliated Islands
   (Lucius G. Eldredge)

3. Cultural Dimensions of Resource Definition and Use in Micronesia
   (William H. Alkire)

4. Implications of History and Culture for Sustaining Development of Renewable Resources on U.S.-Affiliated Pacific Islands
   (Robert C. Kiste)

5. The Critical Role of the U.S. Congress in Fostering Self-Reliance in the Freely Associated States of Micronesia
   (Henry M. Schwalbenberg, S.J.)

6. Fiscal Incentives, Social Support Programs, the Caribbean Basin Initiative and the Development of Renewable Resources in Puerto Rico and the U.S. Virgin Islands
   (Alan T. Udall and Boris Oxman)

7. Organizations Dealing with Renewable Resource Development and Management in Puerto Rico and the U.S. Virgin Islands
   (Hilda Diaz-Soltero and Boris Oxman)

December 1986

These Commissioned Papers were prepared by the outside contractors as an input to an ongoing Office of Technology Assessment (OTA). They do not necessarily reflect the analytical findings of OTA, the Advisory Panel, or the Technology Assessment Board

J952-32
I

Table of Contents

Part A: The Setting for Resource Development

1. Tropical Island Ecosystems and Protection Technologies to Sustain Renewable Resources in U.S.-Affiliated Islands (Arthur L. Dahl) 2

2. Case Studies of the Impacts of Introduced Animal Species on Renewable Resources in the U.S.-Affiliated Islands (Lucius G. Eldredge) 58

3. Cultural Dimensions of Resource Definition and Use in Micronesia (William H. Alkire) 107

4. Implications of History and Culture for Sustaining Development of Renewable Resources on U.S.-Affiliated Pacific Islands (Robert C. Kiste) 151

5. The Critical Role of the U.S. Congress in Fostering Self-Reliance in the Freely Associated States of Micronesia (Henry M. Schwalbenberg, S.J.) 193

6. Fiscal Incentives, Social Support Programs, the Caribbean Basin Initiative and the Development of Renewable Resources in Puerto Rico and the U.S. Virgin Islands (Alan T. Udall and Boris Oxman) 259

7. Organizations Dealing with Renewable Resource Development and Management in Puerto Rico and the U.S. Virgin Islands (Hilda Diaz-Soltero and Boris Oxman) 393

Background Paper No. 1

TROPICAL ISLAND ECOSYSTEMS AND PROTECTION TECHNOLOGIES TO SUSTAIN RENEWABLE RESOURCES IN U.S.-AFFILIATED ISLANDS

by

Arthur Lyon Dahl

1986

Prepared for

U.S. Congress, Office of Technology Assessment,
Integrated Renewable Resource Management for U.S. Insular Areas,
Washington D.C.: U.S. Government Printing Office, 1987.

TROPICAL ISLAND ECOSYSTEMS AND PROTECTION TECHNOLOGIES TO SUSTAIN RENEWABLE RESOURCES IN U.S.-AFFILIATED ISLANDS

Arthur Lyon Dahl

ABSTRACT

Islands are essentially different from continental areas because of their small size and isolation. Their biological populations depend on the rates of immigration and extinction of species, and often include unique endemic species that have evolved to suit island conditions. There are also socio-economic constraints on island human populations, including the high cost of communications, the lack of economies of scale, and the difficulties in supporting the infrastructure and specialization necessary for modern technologies.

The ecosystems present in the U.S.-affiliated islands include lowland rain forest, moist forest and dry forest; submontane and cloud forest on mountains; riverine and swamp forest; mangrove forest; atoll/beach forest; scrub, savanna and grasslands, often in disturbed areas; wetlands and fresh water environments; coral reefs; and lagoons and shallow bottoms. The interrelationships between ecosystems link them together into a single island system. The islands can also be classified into continental islands, volcanic islands, atolls or raised coral limestone islands, or some combination of these structures.

The ecosystems and species contribute in many ways to the maintenance of island life-support systems and the sustainable use of island resources. Different types of protected areas can be used to protect these essential contributions. Other measures may also be necessary to ensure the survival of island species that are a significant genetic resource. Traditional island cultures developed many sustainable resource management and conservation technologies that can be used as models for modern approaches appropriate to islands. Protected area programs must take into account island cultural and ecological factors.

The establishment and management of protected areas will require adequate scientific information, including quantitative information on the sustainability of resources. Protected areas must be planned for multiple benefits, with due regard to the difficulties created for islanders deprived of their land or customary resources. The participation of local people in the planning and management of protected areas is imperative on islands. Regular monitoring of resource use and protected areas is essential to their management, and should feed information into the planning process. Protected areas can contribute to public education, and should be integrated with other protection mechanisms.

To overcome the constraints and take advantage of the opportunities of the island situation, there are several objectives for congressional action, including simplified and appropriate legislation, special programs of technical and research assistance, and support to species protection and educational programs. Actions are proposed for institutions at the international, regional, national (Congress and Federal agencies), and insular government levels, and for private industry, academic institutions, non-profit institutions and traditional organizations. Implementing the proposed actions should lead to the creation of protected areas, a reduction in extinctions, and eventually the more sustainable use of island resources; failure to act will lead to a continuing decline in the ability of the islands to support a human population.

TROPICAL ISLAND ECOSYSTEMS AND PROTECTION TECHNOLOGIES TO SUSTAIN RENEWABLE RESOURCES IN U.S.-AFFILIATED ISLANDS

CONTENTS

INTRODUCTION
    Socio-economic aspects of insularity

ISLAND ECOSYSTEMS: DESCRIPTION, STATUS AND RESPONSE TO STRESS
    Lowland rain forest
    Submontane rain forest
    Cloud forest
    Riverine and swamp forest
    Subtropical moist or seasonal forest
    Subtropical dry forest
    Mangrove forest
    Atoll/beach forest and scrub
    Scrub
    Savanna and grasslands
    Wetlands and fresh water environments
    Coral reefs
    Lagoons and shallow bottoms
    Interrelationships between ecosystems

ISLAND CLASSIFICATION

PROTECTED AREAS AND OTHER NATURAL ECOSYSTEM AND SPECIES PROTECTION TECHNOLOGIES
    Goals for protected area establishment and management
    Goals for species protection
    Traditional resource management and conservation

GUIDELINES FOR THE ESTABLISHMENT AND MANAGEMENT OF PROTECTED AREAS
    Information
    Implementation of protected areas
    Participation by local people
    Monitoring
    Planning
    Education
    Alternative protection mechanisms

SUMMARY: CONSTRAINTS AND OPPORTUNITIES
    U.S. Federal agencies
    Objectives for congressional action
    Institutional actions
    Impacts and consequences of the proposed actions

BIBLIOGRAPHY

INTRODUCTION

Islands are by definition small areas of land isolated by water, and it is their small size and isolation that make them different from continental land areas.

If anything is reduced enough in size, it undergoes an essential change in nature. For example, a herd of cattle can be reduced down to one bull and one cow and still be capable of reproducing the herd. Any further reduction eliminates the capacity for reproduction, and reduction beyond a single animal means slaughtering it and cutting it up. The herd has become something different (meat), and has lost some essential characteristics. The same principle applies to any population or ecosystem. When they are reduced in size (as they are on a small island), they become increasingly fragile, an may eventually collapse if too small.

Small objects have a much greater surface to volume ratio than large objects. In the same way, small islands have a higher ratio of coastline to land than larger land areas. As islands get smaller, they increasingly become coastal zone, but with much less land area to support coastal demands than on a continental coast. Since coastal regions are also more exposed to natural disasters, the increased coastline means the land is less protected and more at risk.

The U.S.-affiliated islands are all quite small. Puerto Rico, by far the largest, is 3435 square miles in area and about a hundred miles across in its longest dimension. Guam is next in size at 206 square miles. All the Northern Mariana Islands together total 184 square miles, as do the islands of Palau. The U. S. Virgin Islands total 133 square miles, and this is still larger than any of the states in the Federated States of Micronesia. American Samoa is 76 square miles, and all the Marshall Islands 70. Since most of the above figures are for island groups, the individual islands are much less; Majuro, the capital of the Marshall Islands, is 3½ square miles in total area. For comparison, the District of Columbia is 69 square miles.

Work in island biogeography (MacArthur and Wilson, 1967, and many subsequent studies) has defined the basic principles for the establishment and maintenance of plant and animal populations on islands (Dahl, 1984). The number of species that can live on an island depends on its size, with a bigger island able to hold more species. This is because on smaller islands with smaller population sizes, it is easier for some to be driven to extinction. The number of species also depends on the distance of the island from sources of colonizers like continents or other islands. It is hard for most land plants and animals to travel over the sea, so the arrival of a newcomer is a rare event after being carried by storm winds, a drifting log or stuck to a seabird's feet. In addition, it is usually necessary for both a male and female to arrive at the same time, and then to overcome the risks of getting established in a new place. The equilibrium island population thus depends on the rates of immigration and extinction, which in turn depend on distance and size.

These principles of island biogeography underlie one of the major problems for the preservation of natural systems on islands. Where the size of the island is already limiting, any reduction in the size of the natural areas or habitats, such as by development, will probably lead eventually to some species extinctions.

Islands have another biological characteristic, they tend to develop new varieties and species (called endemic species) that are found nowhere else. This comes again from their isolation. If there is less mixing with other populations, there is more chance for the rare colonizing organism to develop differences suited to his new environment, or simply to change in some random way over time (genetic drift). The lack of competition may mean that there are several available niches, so a new arrival may evolve into different forms to fit the spaces available (adaptive radiation), as in the classic case of Darwin's finches in the Galapagos Islands. Thus the more isolated islands have a genetic richness and unique ecosystems quite unlike comparable areas on continents. They are also more liable to species extinctions, which represent an irreversible loss of part of the world's genetic heritage.

The best word to characterize the island situation might well be vulnerability. Because of the small size of islands, it is easier for a natural event like a storm or epidemic, or human stress from pollution or development, to affect an entire habitat or ecosystem, and recovery may be slow because the base from which to build is so small. Their isolation means that they may have unique endemic forms, and if something is lost it will be difficult or impossible to replace. Their species and ecosystems have adapted to their isolation through the loss of their defenses and competitive ability, so that they are easily preyed on or out-competed by the many species that man tends to introduce intentionally or accidentally wherever he goes.

The above facts show why islands cannot just be considered scaled-down versions of continents (Towle, 1984). While the island microcosm may be a small simple system providing an instructive example for larger systems such as nations or our whole planet that must learn to live within their limits, it is hard to use the analogy in the opposite sense. The difference in scale is too great.

Socio-economic aspects of insularity

Similar principles to those for biological communities also apply to human societies on islands. Insularity has its own socio-economic peculiarities. Isolation greatly increases the expense of transportation and communications, which may also be much slower and less reliable (especially when you urgently need a spare part). Small size prevents the economies of scale that underlie most modern development, and it reduces the population base over which essential services can be spread. Small communities cannot have the same levels of specialization as large ones, and the amount of infrastructure and bureaucracy they can support is limited. It is thus harder for them to develop or use modern technologies requiring specialized care and maintenance. The more they modernize, the more they become dependent on the outside without necessarily being able to cope. The elaborate requirements of a modern technological society can no more be scaled down to a small island than can a continental ecosystem. Island societies need to evolve their own simple and appropriate ways of doing things, just as islands evolved their own species.

ISLAND ECOSYSTEMS: DESCRIPTION, STATUS AND RESPONSE TO STRESS

The U. S.-affiliated islands share with many other tropical islands a certain number of ecosystem types. These are usually quite similar in structure and function, even if the species which make them up differ greatly from one region to another. The following are the major biomes and habitats that correspond to the island ecosystems (based on Dahl, 1980, with additions from Bryan, 1971; Dahl, 1973; Dahl et al., 1974; Island Resources Foundation, 1977; IUCN, 1985; Newell, 1985; OTA, 1984; and Saenger et al., 1983).

Lowland rain forest

Forest composed of numerous species of fast-growing trees, many exceeding 80 to 120 feet in height, with a closed uneven canopy and sparse undergrowth; often growing on and helping to build the best island soils; complex dynamics in growth and reproduction maintain species diversity.

Puerto Rico: rain forest formerly covered one quarter of the island, mostly on volcanic soils on the lower mountain slopes with more rainfall; a special type occurred on serpentine soils; little of this or any lowland forest type remains today.

Virgin Islands: none.

American Samoa: several types with different dominant species occur on different volcanic soil types; two thirds are now destroyed with the remainder on steep slopes.

Guam: there are both a low limestone forest type and a rich forest with many endemic tree and bird species; only scattered and inaccessible remnants remain.

Northern Marianas: similar to Guam, plus a lowland lava forest in the northern islands.

Marshall Islands: none.

Pohnpei: lowland forest on weathered basalt soil; many endemics; now mostly disturbed.

Kosrae: present with many endemics; nearly undisturbed.

Truk: no undisturbed forest remaining.

Yap: a dense species-rich forest growing on metamorphic and volcanic soils; most is now disturbed or replaced.

Palau: a dense very rich forest with epiphytes and tree ferns grows on old volcanic soils; there is also a species-rich limestone forest growing with very little soil; considerable areas are disturbed.

Lowland rain forests are important for water catchment and for building soil nutrients and humus. They have the highest forestry potential of any island forest, but the land is often required for competing uses like agriculture and human settlements. The ecosystem is naturally resilient; the greatest risk is logging or forest conversion to other uses, often with the loss of significant genetic resources and wildlife. Continuing human disturbance, a lack of seed sources, and competition from introduced plants prevent recovery, which might take decades under good conditions. Reforestation is sometimes attempted, but usually with exotic species as most native species are considered too slow growing to be economic. Planting and weeding in the early years are labor-intensive and expensive. Coverage of forest areas can be monitored by remote sensing to determine if areas drop below minimum sustainable size. With the continuing pressure for land development, information on forest cover should be updated regularly. Floristic composition may also need to be monitored in areas of forest regeneration.

Since most of these forests have already been destroyed, conservation of the remnants is a high priority. Areas abandoned after other uses could be replanted in native species to buffer or expand natural areas, or could be developed for agroforestry to restore some forest values. Once sufficient lowland forest areas have been restored, light selective logging might be possible if accompanied by replanting of logged species.

Submontane rain forest

These are mountainside forests of shorter broad-leaved trees with an even canopy, many epiphytes, and abundant undergrowth including tree ferns and small palms. The dynamics are similar to lowland rain forest.

Puerto Rico: probably occurred formerly on higher mountain slopes.

Virgin Islands: none.

American Samoa: different types grow on ridges and as secondary forest at middle elevations; some disturbed.

Guam: none.

Northern Marianas: none.

Marshall Islands: none.

Pohnpei: found at middle elevations with dense mixed broadleaf and palm forest types; some disturbed.

Kosrae: at middle elevations.

Truk: only 2 acres now remaining on top of one volcanic island.

Yap: none.

Palau: none.

The forests at higher elevations in the islands are essential to control erosion and landslides on the steeper slopes. The topography usually precludes commercial forestry, but a few areas may have agroforestry potential. Such forests are often best preserved for their ecological and scenic values, as wildlife habitat, and as sources of forest products such as medicinal plants.

The principal threat to these forests is unwise land clearing for agriculture, which is generally followed by abandonment after a short period.

Once cleared, introduced weeds may prevent or slow forest regeneration, leading to chronic erosion and frequent landslides. Reforestation is often not practical because of the steep terrain and difficult access. The area covered by intact forest is the best indicator of the state of the ecosystem.

A few submontane forest areas may have potential for tree crops that maintain forest cover. Otherwise their value for water catchment and erosion control outweighs any development potential.

Cloud forest

This is a forest of mountain and ridge tops kept wet by clouds, composed of gnarled trees burdened with mosses and lichens, and with the ground covered with club mosses and ferns. It is often high in endemic species. Little information exists on its dynamics.

Puerto Rico: present on mountaintops.

Virgin Islands: may have been present on mountaintops.

American Samoa: occurs only on the top of Ta'u, undisturbed.

Guam: may grow in a limited area on top of Mt. Lamlam.

Northern Marianas: found on Mt. Tapachau, Saipan; the cloud-covered summits of some other island calderas are unexplored.

Marshall Islands: none.

Pohnpei: occurs at highest elevations, with endemic plants and orchids.

Kosrae: present on mountain top.

Truk: none.

Yap: none.

Palau: none.

The inaccessibility and extreme conditions of the mountain top habitat preclude significant human use of the ecosystem. The area of cloud forests is often extremely limited and they may be threatened by competing uses for their sites such as the construction of antennas and communications relays. Recovery after disturbance is probably extremely slow, as erosion would set in quickly after any damage to the ecosystem. Conservation would seem to be the only appropriate human use, and the area of any essential construction should be kept to an absolute minimum. Studies of cloud forest dynamics and of the possibilities of restoration are needed.

Riverine and swamp forests

These dense forest of water-loving species occur along rivers and in low swampy areas, sometimes inland of mangroves.

Puerto Rico: probably still present, at least in some areas.

Virgin Islands: none.

American Samoa: small amounts occur along streams.

Guam: found along rivers and in moist ravines, now mostly gone except in the south.

Northern Marianas: in ravines of smaller islands, little explored but known to contain rare and endemic plants.

Marshall Islands: none.

Pohnpei: dense forest along rivers and inland of mangroves.

Kosrae: along rivers and inland of mangroves.

Truk: inland of mangroves.

Yap: inland of mangroves.

Palau: along rivers and inland of mangroves.

Riverine forests are very important in erosion and flood control along stream banks and in preventing pollution of water supplies, and they are best preserved for this purpose, although they are frequently cleared for agriculture or land development, as are swamp forests. Replanting of these forests should be possible, since the areas involved are limited and the environmental benefits would be substantial. Human uses are possible as long as the vegetation cover is maintained. Some areas have recreation potential.

Subtropical moist or seasonal forest

The drier Caribbean climate produces lowland forest types not found in the U. S. Pacific islands. The tree species of moist forest are more resistant to drought and may lose some leaves in the dry season.

Puerto Rico: 60% of the island was originally covered by this forest type in the lowlands on the wetter north side of the island; different types occupied alluvial and limestone areas; little of this forest remains today.

Virgin Islands: moist forest formerly covered ¼ of the islands; the fraction that remains is mostly in mountainous or inaccessible areas.

These desirable lowland areas were long since converted to agriculture, industry and urban development, and such uses will continue to be given priority over the natural ecosystem on these lands. If any fragments of original forest remain, they should be protected for their conservation interest.

Subtropical dry forest

A drought-resistant forest with many species and often an understorey of shrubs; slower growing than wet forest.

Puerto Rico: this lowland dry forest once covered 16% of the island on the South side; different communities were distinguished in coastal areas and on limestone. As with other Puerto Rican forests, little of the original ecosystem remains.

Virgin Islands: this was the predominant original vegetation, covering ¾ of the land; today it is considerably reduced.

These dry areas have little potential for forestry production and tend to be converted to grazing land. The forests along the immediate coastal strip may be important in filtering runoff from the land and thus in preventing coastal pollution by sediment and agricultural chemicals. Their rich species composition would require relatively large areas to maintain reproduction and regeneration in the ecosystem, and this makes conservation of such forests more difficult.

Mangrove forest

Salt-resistant trees with stilt roots or pneumatophores growing in the intertidal range along ocean shores or estuaries. The leaves falling from the trees provide food for marine life sheltering among the roots or exported to the lagoon and coastal waters.

Puerto Rico: there are about 25 square miles of mangroves scattered around the coast, representing a significant and productive resource.

Virgin Islands: while scattered mangrove plants occur along the coast, mangrove forests only survive at Salt River, St. Croix and Jersey Bay, St. Thomas; the largest areas have already been filled in for development.

American Samoa: mangroves only grow in Pala Lagoon (under stress from development) and at Aunu'u.

Guam: some small mangrove areas, particularly in Apra Harbor, where there has been much dredging, filling and development.

Northern Marianas: limited areas in the southern islands.

Marshall Islands: in small depressions on a few atolls.

Pohnpei: 13,690 acres of mangrove forest along the coast and in estuaries of Pohnpei, and a small amount on Pingelap Atoll.

Kosrae: 4,030 acres around the island.

Truk: 3,315 acres around the main islands.

Yap: 906 acres on Yap and small amounts on Elato and Woleai Atolls.

Palau: 9,344 acres in estuaries and along the coasts of the archipelago.

Mangroves support major coastal fisheries producing fish, oysters, crabs and other delicacies, and they supply wood and other forestry products on some islands. They also trap and stabilize sediment, thus building land and protecting reefs and lagoons from pollution. They are an important factor in coastal protection from storm damage. In urban areas they may purify the organic wastes and pathogens in urban runoff. Several commercially important fish species use mangroves for breeding or nursery grounds, and food produced in mangrove forests may contribute to the productivity of lagoons and coral reefs.

Storms may damage mangroves, although they tend to regenerate quickly after storm damage. On the other hand, human-induced stress can be disastrous; mangroves are often killed by changes in land runoff or water circulation which alter delicate salinity balances, and oil pollution can wipe out mangrove areas for years. Stressed mangroves will drop their leaves, and may die if the stress remains too long. If conditions permit seedling reestablishment, then the forest can regenerate in 10 to 50 years. Replanting mangroves has become a current practice in Florida at costs equivalent to reforestation on land.

If mangrove forests are carefully managed they can sustain a high fisheries output and some limited forestry production. However their undeserved reputation as nasty swamps, reinforced by the pressure to create land, has led to their destruction in many areas.

Atoll/beach forest and scrub

This forest and scrub type composed of a few widely-distributed species of trees and shrubs occupies sand and rubble on islets and along the coastal beach strand close to sea level.

Puerto Rico: present in some areas.

Virgin Islands: present.

American Samoa: widespread; special types occur on Swain's Island and Rose Atoll.

Guam: common, including some endemic species.

Northern Marianas: occurs on some of the southern islands.

Marshall Islands: this was the major forest cover on atolls, with a variety of types; today the natural forest has largely been replaced by coconuts and breadfruit except on some northern atolls such as Wotho.

Pohnpei: occurred on atolls and behind the beaches of high islands; now often replaced by planted trees.

Kosrae: behind beaches.

Truk: on atolls and islets, and in some coastal areas.

Yap: on atolls and behind beaches, usually replaced by coconuts.

Palau: in a few areas behind beaches and on Kayangel Atoll.

The coastal fringe of vegetation helps to stabilize the coastline and protects the land behind it from storm damage. Some of the plants also provide traditional materials. The plants in this ecosystem are quite resistant to all except destruction by man. Land is so limited on atolls that it is hard to justify leaving large areas in natural forest except in nature reserves and seabird breeding areas; however on high islands, tourism, recreation and residential developments are often more destructive of these forests than necessary, and their preservation as a storm defence and for their scenic value is in the public interest. As early colonizing species they can recover quite readily, but they could be replanted where rapid stabilization was needed.

Scrub

Scrublands or thickets with woody shrubs to 15 feet high often occur where water or soil are too limiting for forest development.

Puerto Rico: present, often as secondary regrowth on drier abandoned lands.

Virgin Islands: present.

American Samoa: mountain scrub grows on Matafao and Piao mountains, Tutuila.

Guam: found on the rocky limestone coast, and also on areas of southern Guam with some endemics.

Northern Marianas: grows on coastal volcanic rock in the northern islands and on the limestone coasts of the southern islands.

Marshall Islands: some scrub forest remains on the northern islands.

Pohnpei: occurs on rocky coasts and in some ravines.

Kosrae: present.

Truk: present.

Yap: present in some degraded areas.

Palau: found on the outer edges of limestone forest, on rocky coasts and in strip-mined areas.

As vegetation cover on difficult terrain, scrub often has an important role in erosion control and in recolonizing degraded areas. While it seldom has productive human uses, neither does the poor soil in which it grows. The major threats are construction and fire.

Savanna and grasslands

Grasslands or grass with scattered trees or shrubs (savanna) are often created and maintained as grassland by frequent burning.

Puerto Rico: considerable areas of man-made grassland exist, maintained as pasture or covering degraded and abandoned agricultural land.

Virgin Islands: present in former agricultural areas.

American Samoa: only as early regeneration after disturbance.

Guam: extensive fire-adapted areas occur on the southern part of the island.

Northern Marianas: extensive areas of grassland and tree savanna on the northern volcanic islands; man-made grasslands on Saipan and other islands.

Marshall Islands: found on the smaller islets of some atolls.

Pohnpei: present, often from burning.

Kosrae: present.

Truk: present.

Yap: now predominant; grows on clay soils or where frequently burned.

Palau: there are savanna and woodland on clay soils, and fire-maintained grasslands.

Grasslands and savannas are an ecosystem resulting on tropical islands from human disturbance, usually burning. Regrowth is usually rapid after a fire. The grasses do help to prevent erosion, and may contribute to scenic beauty, but the repeated burning degrades the soil, and the fire often spreads into and destroys adjacent areas of valuable forest or vegetation. Grasslands can be used as pasture for livestock, but overgrazing can be a problem, particularly in erosion-prone areas subject to drought followed by heavy rains.

If fires are controlled, scrub or secondary forest will usually invade and replace the grasses eventually. Grasslands can also be reforested, but accidental burning can be a problem.

Wetlands and fresh water environments

These include fresh water marshes and reed swamps, lakes, rivers and streams with aquatic plants and fresh water fauna, as well as salt marshes with saline water fauna. On small islands these ecosystems may be very restricted, and their tiny populations may be particularly vulnerable to disturbance.

Puerto Rico: there are some rivers, marshes and other ecosystems; salt marshes may occur behind mangroves.

Virgin Islands: no permanent rivers or streams exist; salt ponds are common in bays behind mangroves.

American Samoa: streams and coastal marshes are common, but most of the latter are disturbed; there is a permanent lake in Aunu'u crater, an intermittent lake in Ta'u crater, and a unique mud lake on Aunu'u.

Guam: there are some streams and rivers, extensive reed swamps, some fresh-water and salt marshes, and a man-made lake, forming some very limited fresh-water habitats with rare native plants and an endemic water fern.

Northern Marianas: some small fresh-water and salt marshes, fresh-water lakes on Saipan and Pagan (with hot springs), brackish lake on Pagan, and an intermittent lake in Anatahan caldera.

Marshall Islands: fresh-water pond on Lib; some tidal salt marshes.

Pohnpei: streams and rivers with fresh-water fauna, lakes, ponds, swamps and marshes.

Kosrae: short streams and other fresh-water habitats.

Truk: low swamps and marshes.

Yap: fresh-water streams, ponds, swamps and marshes.

Palau: streams and rivers, lakes, ponds, swamps, fresh-water and salt marshes; unique marine lakes with unusual ecosystems occur in limestone islands.

In spite of heavy rainfall, fresh water can often be limiting for development on islands, so all ecosystems associated with water supplies are important. Marsh and stream vegetation may slow run-off and prevent erosion, flooding and dirtying of the water. Fresh-water shrimp, fish and eels may be important local foods. Fresh-water ecosystems may filter pollutants and thus protect reefs and lagoons.

The small size of many fresh-water environments makes them vulnerable to natural damage by storm and drought and to disturbance and destruction by man. Some ecosystems may be adapted to temporary disappearance, or to the wide salinity changes of salt marshes and ponds, reappearing quickly when conditions permit, or going through a series of successional stages. However, they may be very sensitive to heavy sedimentation from construction, and to pesticides, agricultural chemicals and other pollutants. If the whole environment is wiped out, recovery may be very slow even if the sources of stress are removed. Some islands have endemic species associated with these habitats.

Recovery of damaged fresh-water ecosystems usually requires restoring natural conditions and removing sources of pollution, which can be difficult and expensive as experience in the U.S. and elsewhere has demonstrated. Even where the protection of the natural ecosystems may not justify this, the need for unpolluted water supplies usually does.

Monitoring of water quality or sensitive species may permit early detection of problems. However, most island aquatic ecosystems are still very poorly known scientifically, and more work is needed to describe ecosystem functioning and tolerances.

While extraction of too much water may endanger some of these ecosystems, the sustainable use of water and fishing is not too difficult to regulate. The greatest threats come not from such direct uses but from the destruction of water catchments, pollution, or conversion of the land to other uses. Development controls and careful land management are necessary to protect fresh-water ecosystems and their resources.

Coral reefs

These are rich and complex ecosystems which build massive limestone reef structures with their skeletons. Their high productivity is maintained by efficient retention and recycling of nutrients within the ecosystem. Some reefs are built primarily by corals, others by coralline algae. Reefs may be subdivided into the following structural types:

Atoll reefs form a lagoon unassociated with any major landmass.

Barrier reefs are separated from the land by a large lagoon.

Fringing reefs grow directly out from the coastline and are not separated from it by more than a shallow depression.

Lagoon or patch reefs develop in the sheltered waters of a lagoon.

Submerged reefs have subsided below depths at which reef growth has been sufficient to regain the surface.

The different types of reef and different parts of reef structures may have quite different communities and functions, but these are too complex to distinguish here.

Puerto Rico: barrier, fringing and patch reef complexes occur at many places around the coast, but only a few further offshore or far from river mouths are still in good condition; most reefs are dead or dying as a result of pollution and sedimentation from land run-off and dredging.

Virgin Islands: there is a major bank barrier reef including an algal ridge (rare for the Caribbean) off the east end of St. Croix, and many other reef complexes with barrier, fringing and patch reefs elsewhere; some reefs have been damaged by pollution.

American Samoa: the main volcanic islands are in large part bordered by fringing reefs, and there are two atolls; dredging, pollution and dynamiting for fish have damaged some reefs and the inner reefs of Pago Pago Harbor have been destroyed by development.

Guam: there is a barrier reef and lagoon near Cocos Island and a variety of fringing and patch reef types elsewhere; some reefs have been affected by pollution and heavy human use, and probably by the heavy fighting during World War II.

Northern Marianas: fringing reefs are common and often broad in the southern islands, and some have been damaged by fishing with explosives (and earlier by warfare); little is known about the northern active volcanoes, but they probably have little more than a veneer of living corals.

Marshall Islands: all the islands are atolls built by coral reef ecosystems; there has been reef damage on some atolls from the pressures of the human population and from earlier nuclear weapons testing and associated military activity.

Pohnpei: an extensive barrier reef encloses a lagoon with fringing and patch reefs on Pohnpei; the outer islands in the state are all atolls.

Kosrae: the island is largely surrounded by fringing reef.

Truk: a major barrier reef with islets encloses the Truk lagoon which contains complex reef structures; there is considerable damage from fishing with explosives, and earlier from the sinking of a whole Japanese fleet in the lagoon; the outer islands are all atolls.

Yap: wide fringing reefs surround the main islands of Yap; the outer islands are all atolls.

Palau: the very rich and diverse coral reef areas include barrier, fringing and patch reefs; some damage is caused by destructive fishing, and earlier from W.W. II; there are also some atolls.

Coral reef ecosystems are productive both biologically and geologically. An active reef can build islands such as the atolls of Micronesia, make sand for beaches, and repair itself after storm damage, but if the reef-building processes are disturbed, erosion will take over and the reef will deteriorate. Reef fisheries can be extremely productive, averaging up to 25 tons per square kilometer per year in American Samoa (Wass, 1982) where they are a major protein supply for the local population. They are an important tourism resource, protect coastlines from erosion, and supply organisms of pharmacological interest.

Reefs are subject to occasional natural disasters, and may go through cycles of growth and destruction followed by consolidation and new growth. Hurricanes frequently smash coral reefs, but the broken fragments can usually regenerate within a decade. Abnormally low tides, temperature changes, torrential rains, epidemic diseases and plagues of predators like the Crown-of-thorns starfish may also kill off corals temporarily. Human destruction of reefs is most often by sedimentation from land erosion or dredging; the sediment smothers the corals and cuts off the light they need to live. Man also blasts and dredges reefs, smashes and poisons corals while trying to catch fish, and pollutes reefs with urban and agricultural runoff, oil and industrial wastes. Even when reef damage was originally caused naturally, man-caused stresses often interfere with the more sensitive processes of reproduction and settlement, preventing the coral reef ecosystem from recovering normally, and leaving it degraded and less productive. The cumulative effects of increasing human impacts are creating a crisis situation for reefs in many areas.

It should theoretically be possible to "replant" corals in the same way trees are replanted to make a forest, and some experiments along these lines are now being attempted, but restoring any complex ecosystem is extremely difficult and much more research will certainly be needed. There are monitoring techniques now available to detect changes or deterioration in coral reefs (Dahl, 1981; Gomez and Yap, 1984).

Some traditional cultures have sustained high fisheries yields from coral reefs, generally through some form of limited assess combined with other controls and an intimate knowledge of the resource, but modern legal systems for marine areas discourage this kind of management. Strict controls over activities in the coastal zone and in adjacent watersheds, together with careful fisheries management and a network of protected areas should permit sustained use of reef resources. The Australian Great Barrier Reef Marine Park Authority has been successfully pioneering effective approaches to coastal management in coral reef areas, balancing use and protection.

Lagoons and shallow bottoms

The enclosed waters inside atolls or behind reefs in coastal areas form ecosystems with special hydrographic conditions, including considerable variations in salinity in closed lagoons. Lagoon bottoms and other shallow coastal waters can support highly productive communities such as sea grass beds and algal beds, as well as sand and mud bottoms dominated by animals on and in the sediment.

Puerto Rico: present behind barrier reefs and other offshore features; frequently affected by heavy sedimentation from the land.

Virgin Islands: extensive in bays, inside the barrier reef and along the shelf; damaged in some places by dredging.

American Samoa: open atoll lagoon at Rose Atoll; closed freshwater lagoon at Swain's Island; Pala Lagoon on Tutuila has been damaged by dredging and pollution.

Guam: Cocos Lagoon.

Northern Marianas: shallow lagoon inside some reefs on Saipan and Tinian.

Marshall Islands: all the atolls have large open lagoons totalling 4,300 square miles except Namorik, which has a closed lagoon.

Pohnpei: 340 square miles including an extensive lagoon with sea grasses around Pohnpei, and within all atolls.

Kosrae: some shallow lagoons inside the reef.

Truk: over 2,000 square miles of lagoon including 820 square miles at Truk and the remainder within atolls; there is a closed lagoon at Namoluk.

Yap: some shallow lagoons with sea grasses within Yap reefs and about 400 square miles of atoll lagoons; Eauripik has a closed lagoon.

Palau: 525 square miles of lagoons within the barrier reef plus Kayangel Atoll and Helen Reef.

Algal and sea grass beds are very productive ecosystems that serve as pastures for fish and other animals of commercial importance. They also stabilize sedimentary bottoms and thus help to prevent coastal erosion. They have some capacity for absorbing organic wastes and sediment. However, heavy sedimentation can cut off the light to and smother bottom communities. Seagrasses are particularly vulnerable to dredging and to anchor and propellor damage, and holes cut in the bed may take years to regenerate; one dredge site in the Virgin Islands was still barren 40 years later (Island Resources Foundation, 1977). It might be possible to replant sea grasses, but it would be technically difficult to stabilize the bottom enough to prevent the loss of plantings. Monitoring the area and density of algal and sea grass beds is the best way to detect changes, and this can usually be done easily by remote sensing. The infauna of animal-dominated bottom communities must be sampled with a grab. The many non-destructive uses of lagoon areas can continue as long as care is taken to protect the bottom from damage.

Interrelationships between ecosystems

On small islands where many different ecosystems are in close proximity, the interrelationships between ecosystems are often critical to the functioning of the whole island system. The forest and other vegetation types build and hold island soil, creating fertile conditions and protecting the coastal waters from erosion. The successional sequence of ecosystems from pioneer species to mature forest restores soil fertility in areas left fallow, but the cycle depends on the presence of nearby natural ecosystems to provide the seeds, and sometimes on animals and birds to transport them. The mangroves similarly filter land runoff. The forest is also essential to managing the island fresh-water regime, trapping and holding water so that ground-water supplies are recharged and streams flow year round, and reducing reef damage from fresh-water floods. Nutrient inputs from the land may be important in the fisheries and productivity of coastal waters, and in some cases the reverse is true, as seabirds may bring nutrients from the sea and deposit them on land. The production of coral limestone and sand by coral reefs and lagoon algae builds land areas which can then be colonized by terrestrial ecosystems. Reefs, lagoons and mangroves are all important in controlling coastal erosion.

Often organisms move between ecosystems and thus provide links between them. Some fish shelter on the reef, feed in the seagrasses and breed in the mangroves. Coconut crabs live on the land but breed in the sea, while turtles live in the sea but breed on the land. The breeding areas for such animals as turtles and seabirds are critical habitats, essential for their survival, where they are particularly vulnerable.

The close links between the major ecosystems mean that the island is in many ways a single system, and the degradation of any part of it will have effects on the productivity of the whole island. Even areas developed for human use depend on natural ecosystems for many of their essential renewable resources. The cycles of water and nutrients, the flows of materials and the movements of animal populations must therefore be managed for the island as a whole, with each ecosystem playing some significant part.

ISLAND CLASSIFICATION

Islands are generally classified into four principal types on the basis of their structure and geological origins (Dahl, 1980).

Continental islands are extensions of continents or fragments of continental crust. They have rocks of continental origin with a complex geological structure and composition producing many soil types.

Volcanic islands are the tips of volcanoes rising from the sea bed. Their underlying basaltic rock may be in the form of lava or volcanic ash. Young volcanic islands may be shaped like a cone or shield; older islands are eroded into very steep and rugged topography. Young volcanic soils can be quite rich, but as they age heavy rainfall may wash away essential soil nutrients.

Atolls are low coral islands formed when a volcanic island sinks beneath the sea while the coral reef surrounding it continues to grow up to the surface, forming a more-or-less ring-shaped reef. The land area on atolls is made from sand and rubble thrown up on top of the reef by waves and storms. Atolls generally have little or no soil.

Raised coral limestone islands result when tectonic processes lift an atoll or island coral reef above sea level, forming an exposed platform of coral limestone. Such limestone is very porous and water percolates through it quickly. The soil on raised limestone may be limited unless volcanic ash, alluvial deposits from adjacent mountains, or lagoon sediments have collected on top.

An island may be made up of more than one type of structure, such as a continental island with raised coral limestone areas, or a volcanic island surrounded by a barrier reef like an atoll.

These types of island structures have a strong influence on the ecosystems and natural communities that develop on them. They also affect the way these natural systems respond to human stress or disturbance, and they may show different kinds of environmental vulnerability. For example, volcanic islands may be more susceptible to erosion, while coral islands may be particularly sensitive to ground water pollution and the rapid loss of soil nutrients and organic matter. Such responses are common to all islands of that type, so that a knowledge of the structure may help to predict development possibilities and environmental impacts.

The U.S.-affiliated islands represent all of the major island types:

Puerto Rico is a continental island with areas of volcanic rock and of raised coral limestone.

The Virgin Islands are also basically continental in origin, with St. Thomas and St. John on the Puerto Rican Plateau, and St. Croix on a ridge of sedimentary rock.

American Samoa includes the volcanic islands of Tutuila, Aunu'u and the Manu'a group, as well as two atolls, Rose and Swain's.

Guam is basically a raised coral limestone island with some weathered volcanic soils on the southern hills and plains and a few low islets on the coral reef.

The Northern Mariana Islands include a southern chain of raised coral islands from Farallon de Medinilla through Saipan and Tinian to Rota, and a chain of volcanic islands in the north ranging from an almost barren active volcano to densely-colonized young volcanic islands.

The Marshall Islands are all atolls or low coral islands.

Pohnpei, Kosrae and Truk are volcanic islands, while Yap is a continental island with metamorphic and volcanic soil types. Each of these high islands is the center of a state including a number of surrounding atolls and one raised coral island, Fais.

Palau is a continental island with weathered basaltic soils and adjacent raised coral limestone islands, barrier reef and two atolls.

PROTECTED AREAS AND OTHER NATURAL ECOSYSTEM AND SPECIES PROTECTION TECHNOLOGIES

The value of the conservation of nature can be measured in several different ways. On a planetary scale, the genetic resources represented by the unique species and varieties of islands should be preserved for their possible contributions to human betterment and their scientific interest. Protecting viable samples of each of the ecosystems of the planet, including the unique island ecosystems in each geographic area, is important to the future well-being of mankind. More locally, natural communities maintain essential ecological processes and life-support systems on islands on which all living things including man depend; if they are not protected, islands become deserts not worth living on. Conservation can also contribute to the sustainable use of island resources like forests and fisheries.

Each island ecosystem has particular contributions to make to the sustainable development and management of island renewable resources. The following are some of the contributions which can only be ensured through the protection of these ecosystems and the species that compose them.

The **lowland forests**, including **rain forest, moist forest,** and **dry forest,** all occupy land that is frequently required for other uses. However, these forests contain useful predators that control mosquitos and insect pests in agriculture. They help to shield adjacent agricultural areas from storm damage. They are important in water catchment and maintaining ground water levels and soil moisture. They prevent erosion on slopes. They restore soil fertility in systems of shifting cultivation. They can provide wood and other forest products on a renewable basis. They are habitat for birds and fruit bats that may be local foods. Obviously it is in the general interest to preserve some proportion of the lowland forests for all of these values, particularly where they are greater than the alternative agricultural value of the land as is the case in at least some local areas. The different (and not always compatible) uses of forests could be met through some combination of protected natural areas, forests managed for local wood production, and agroforestry, plus forest fallow where appropriate, depending on the island and population size, soil type, etc. It is particularly important that forest be re-established on degraded or abandoned agricultural land if island productivity is to be sustained. Eventually forest destruction must be balanced by forest regeneration if island needs are to be met on a continuing basis. Some tree production needs can even be met by the increased use of trees in urban areas and along roadsides which often occupy a significant proportion of an island's surface.

Submontane rain forest has similar values to lowland forest except that the steeper slopes and higher rainfall increase its importance for water catchment, flood prevention and erosion control. While some selective logging and agroforestry may be compatible with these values, agriculture is seldom sustainable, and the maintenance of water supplies and the sustained use of the most productive lowland areas free from droughts and floods requires that protection be given priority in mountain areas. There may also be more endemic species in these higher elevation habitats.

Cloud forests cover very limited areas on those islands where they occur, and their main value, apart from their often unique species, is in water retention and erosion control.

Riverine and swamp forests play important roles in erosion and flood prevention and the stabilization of water flow, roles that generally outweigh the alternative uses for the small amount of land they usually occupy.

Mangrove forest has such importance for fisheries productivity and coastal protection that it should be maintained as a productive resource. Some limited wood cutting may be a sustainable use compatible with these functions. A small part of the mangroves on an island could probably be converted to other productive uses such as aquaculture ponds, but at least half should be assured of some protected status. The gradual nibbling away at mangrove areas for land reclamation should be avoided. The agricultural use of such land has seldom proven sustainable, and the sites are too low and flood-prone for wise urban use.

Atoll/beach forest and scrub have already been replaced by coconuts or other human uses in most areas except where they stabilize the sand and provide protection along the coast. Most of the species are widespread and not in danger, and many places where they still occur have no development potential. They can be an important habitat for seabird breeding in remote areas, in which case the area should receive protection.

Scrub communities are seldom in danger on islands, and if anything may spread as secondary regrowth after land disturbance. Scrub lands should be protected from fire, which can lead to serious erosion.

Savanna and grasslands are relatively unproductive ecosystems maintained by frequent burning. They seldom represent the best sustainable use of island land resources except in some of the driest areas or for limited livestock production (in which case they should be intensively managed). If fires can be controlled, grasslands should preferably be reforested.

Wetlands and fresh water environments frequently harbor food species and species of considerable conservation interest in the islands. The importance of fresh water supplies makes protection and careful management of these resources essential. Wetlands also help to prevent flooding during tropical downpours by accumulating excess water and thus regulating runoff. Accelerating runoff by stream or drainage "improvement" may damage coral reefs and other coastal resources. These values of natural systems are frequently not appreciated when land is developed, resulting in greater human catastrophes. None of these environments should be modified or reduced in size without careful study of the consequences.

Coral reefs must be carefully protected and managed to maintain their geological and biological productivity, as they can be a significant renewable resource for many islands. This requires both preventing damaging uses within coral reefs areas themselves, and controlling the external factors such as land runoff, sedimentation and pollution which are frequently responsible for degrading reefs. On smaller islands and atolls the entire reef may represent a single system with fish migrating and populations and materials exchanged over the whole area of reef and lagoon. The sustained use of reef resources thus requires management of the complete coastal system. While some parts can be altered or developed with only minor impacts, critical habitats must be protected, and these are often not well understood. Coral reef fisheries have proven particularly susceptible to overfishing despite the impression of great fish abundance, and fishing pressure must be regulated carefully for sustainable yield.

Lagoons and shallow bottoms support important fisheries, but the small volume of the overlying waters makes them easily affected by pollution. As with other coastal resources, the sustained use of these productive resources requires management on the land as well as in the sea.

Goals for protected area establishment and management

Protected areas like national parks and reserves are one approach to the conservation of species and ecosystems through legal protection controlling entry into and use of the area. There are different kinds of protected areas adapted to different requirements for the use and conservation of resources. Where a species or ecosystem is sensitive to any human interference, then a strict nature reserve is appropriate. Large areas where conservation is compatible with recreation and education can be made national parks, and small areas natural monuments. Where some management is necessary to protect a species or maintain its habitat, managed nature reserves or wildlife sanctuaries can be created. The scenic beauty and traditional interest of inhabited areas can maintained through declaration as protected landscapes. Temporary resource reserves can be established in areas where decisions on development must await further study. Marine reserves permit the protection and management of important coastal resources. If local inhabitants want protection of their traditional life-style and resources from outside interference or development pressures, then an anthropological reserve or customary protected area can be created. Areas requiring the careful balancing of different resource requirements such as watershed protection, hunting and the gathering of traditional forest products can be made into multiple use management areas. It is thus possible to adapt the kind and degree of area protection to almost every local circumstance.

Goals for species protection

Since many species requiring conservation measures cannot be localized only in reserves, they may require direct legal protection. This is particularly important for endemic species that are rare or endangered, as well as species endangered on a world basis, and those subject to such heavy local use that they may be driven to extinction on the island. Any extinction of a species is an irreparable reduction in the world's genetic heritage, and the disappearance of a species from an island means a reduction in that island's resource base and perhaps its ecological stability. Endangered species should be given protection from all disturbance and use. For rare species with culturally-important traditional uses, it is often possible (and politically necessary) to allow limited taking for those traditional uses only, as long as such use does not threaten the survival of the species. Other species may require permits limiting the number of users, limits on the numbers taken, or closed seasons on taking (usually during the breeding season) in addition to the inclusion of the necessary habitats in protected areas.

Traditional resource management and conservation

Traditional island cultures, particularly in the Pacific, developed elaborate systems for the management of their local resources which include some useful models for sustainable management and conservation on islands. Where resources were abundant relative to the local population or the technology for taking the resource, enough was taken for immediate use, and the rest was left for the next time. Wealth was accumulated as traditional money or obligations, not as resources, which were shared according to need. Where a resource was scarce, different types of conservation measures were practiced, including: restricting the number of consumers; restricting access to the resource; creating taboo areas (reserves), temporary closed areas or closed seasons; and using the resource only on limited occasions (for ceremonies or in times of famine).

Land was not owned as it is in western countries. The land and reefs belonged collectively to a village or family, and each individual had a complex set of rights to grow crops on certain plots of land and to hunt or fish in certain areas. Clearing land often established the right to use it, while land left unused might eventually revert to the common holding. The peoples' collective attachment to their land, the home and burial place of their ancestors, is very strong, making the taking of land even for essential public purposes very difficult.

Each village had its own local experts on forests, agriculture, fisheries and other practices or resources who advised on their use and management. The knowledge of these local experts compared favorably with the best of modern science (Johannes, 1978; Dahl, 1985a). Unfortunately, the cumulative impact of missionaries, colonial administrators, school systems and the import of western values and technologies has largely destroyed these traditional management systems and the knowledge on which they were based. The cultural loss has generally been greater in the U. S. territories then in many other island countries with less outside impact.

Modern attempts to manage island resources for sustainable use must take into account these traditional factors as much as possible. Traditional management practices may have proven their worth over centuries, while the track record for modern resource management is not very good. The western concept of ownership is too inflexible for islands where a small amount of land must be shared among many multiple uses, just as making everything below high water mark the public domain destroyed the careful management of reef and lagoon areas that accompanied traditional collective ownership. While it is not possible to return to the closed world of the traditional island society, it may be possible to seek inspiration there for new approaches better adapted to island problems. Where new resource management technologies are seen to reinforce traditional ways or ideas, they will have a better chance of success, while foreign ways imposed from outside are doomed to failure.

This is particularly true of protection technologies for island land and native species. There is strong resistance in the Pacific Islands for any government taking of land or imposition of land-use controls like zoning. The same applies to anything seen as interfering with what is perceived as a traditional cultural practice, such as hunting native birds. Protection of any resource in the islands will only work if it has the support of the local population, and particularly the resource users, the traditional leaders, and the heads of the land-owning families. Thus a great deal of patient work in education and public information is necessary to lay the foundation for conservation action. Even if protection measures are put in place, enforcement cannot work where everyone is a friend or relative of the enforcing officer. In the islands, without public support, enforcement is impossible; with it, enforcement is hardly necessary.

While the inhabitants of the Caribbean islands are not as deeply rooted in traditional cultures, the requirements of island life have led to similar social constraints and opportunities. Only in Puerto Rico is the scale of the island community so large that much of the discussion here of social and cultural factors is of limited applicability. However the situation there is less foreign to the American experience then that of the very small islands.

GUIDELINES FOR THE ESTABLISHMENT AND MANAGEMENT OF PROTECTED AREAS

It should be clear from the above sections that protected area establishment cannot be the same on islands as it is in the continental United States. Both the nature of the protected areas and the means by which they are created and managed must be modified to suit the social, cultural and ecological conditions of the islands. The following are some guidelines for creating and managing protected areas in the U.S.-affiliated islands.

Information

Great progress has been made in the last few years in the preparation of inventories of resources for the U.S.-affiliated islands. Some are complete and others are still in progress. However there are gaps in the inventories for some resources and for some areas. Also, the inventories have concentrated on the most obvious organisms, and many less evident but ecologically important groups have not yet been studied.

Inventories tend to be lists and static descriptions at one point in time; much less is known about the ecosystem dynamics and the broader functioning of the island systems. The sustainable use of resources requires both knowledge of the appropriate techniques for their use, and quantitative information on how much use is sustainable. The quantitative information is largely lacking, particularly since island conditions can be quite variable from year to year. Only experience with long time series of basic environmental information will make it possible to say if what seems sustainable this year will also be sustainable next year.

An island system is also more than the sum of its parts. While there may be sectoral descriptions of different island resources (forests, wildlife, the coastal zone), there is a lack of information on the interrelationships between ecosystems that make up the whole island system, such as transfers of nutrients, the water cycle and water movement, the transport of soil or sediment, and the distribution of the seeds or young of island plants, animals and marine life. If resources are to be sustained in the long term, the whole island must be managed as a unit to ensure that essential life-support systems like the fresh water supply and reserves of soil and nutrients are not degraded.

Implementation of protected areas

A network of protected areas should be a basic component of island management, protecting sensitive parts of the island system from overuse. Since the heavy demand for resources on a small island makes it difficult to dedicate areas exclusively to single uses, protected areas need to be planned to combine species and ecosystem protection with other requirements for resource management so as to make the most efficient use of island resources. Indeed, in the context of traditional collective land tenure and the modern lack of tenure in the marine environment, protected areas of appropriate kinds may be one of the best ways to manage resources in the implementation of comprehensive island management plans.

In an island situation such as that in the Pacific where land is limited and has been held in customary ownership for generations, protected areas that exclude people and their activities can be difficult to implement. There may be no land available to exchange for that requiring protection, and no monetary payment can fully compensate for the spiritual ties to the land of one's ancestors. It is hard to displace people when there is no other place available on their island that they can call their own. Even controls on land use or development may mean lost opportunities difficult to replace when there are few alternatives available.

Conservation is also difficult in the face of population pressures. If an island's population approaches or exceeds its carrying capacity, no resourc will be left untouched and restrictions on exploitation become impossible t enforce. Managing the human population is as much a part of the sustainable utilization of an island as is managing any other resource.

Participation by local people

Protected areas can only be effective on an island if local people participate from the beginning in the conception of the areas, the definition of their boundaries, the preparation of management plans and regulations, and the enforcement of the controls adopted. There is now sufficient experience in both the Pacific and the Caribbean to demonstrate that there is no substitute for public support and involvement (SPREP, 1985; Geoghegan, 1985).

The protected area concept also needs to be adapted so that it can be applied to land in individual or collective ownership with the agreement of the owners. This carries public support to its logical conclusion, and avoids the problem of cutting people's cultural and spiritual ties to their land. The law should provide the necessary authority and guarantees; the need for protection can be identified by the government or by the local people; regulations and management plans are decided by a committee of land owners in consultation with the government authorities; the protected area agency provides tecnnical advice and perhaps some financial support or management assistance; and enforcement is by the land owners and/or park staff, as appropriate. With this approach, protection can be achieved in a culturally-acceptable fashion, and at less cost than if government acquisition of the land were required.

Monitoring

Resource management requires periodic reports on the state of the resource, just as financial management requires regular accounts. Resource inventories and monitoring are essential for the management of protected areas, and for the control of activities in adjacent areas that might have an impact on the protected area. However, most studies or surveys on islands have been made by scientists visiting for short periods. Few islands have a local scientific capability for such monitoring, and visiting scientific teams are expensive. Effective resource management will therefore require the development of resource inventory and monitoring techniques that can be supplied cheaply or carried out locally with available manpower. Techniques that allow local people without scientific training to monitor coral reefs have been developed (Dahl, 1981) and similar approaches could be evolved for other resources. The rapid development and improving resolution of remote sensing technologies also hold great hope for economical island monitoring (Bour et al., 1985).

Again, it is important that local people be involved in monitoring. When they see for themselves what is happening to a resource, they will be motivated to control their own behavior (assuming they have options open to them). There will be no suspicion or questioning of the wisdom of outside experts. They will be able to judge if the protected area is achieving the goals for which it was established, or if its regulations or boundaries need modification. Monitoring information will be put to use in the most immediate and direct way.

Planning

Information from inventories and monitoring also must be fed into the physical and economic planning processes. This can be relatively simple on islands where organizational structures are small-scale and there are few layers of bureaucracy. Indeed, there is a danger of imposing procedures too cumbersome for the size of the community. Simple short reports and maps or map overlays supplied to the planning office may often be sufficient. Ideally a microcomputer could be programmed to process the data and present it in simple forms which could be used and manipulated by island planners.

Education

Protected areas should themselves become part of the educational process for the island public. In those areas or parts of areas open to the public, interpretive materials should explain what is protected and why. Parks should become environmental education laboratories for school groups. The first protected areas on an island should be carefully chosen and developed to demonstrate the value of parks and reserves to decision-makers and the general public. Further protected areas can then be established as public understanding and support increase. Education is equally important for species protection; the public should come to identify with and want to help their local protected species. Fortunately, the smaller the island, the easier it is to get the message to the whole population.

Alternative protection mechanisms

Achieving effective protection of species and ecosystems on small inhabited islands requires a combination of approaches. Protected areas are useful for critical habitats and areas where human interference must be strictly controlled, but they can never be large enough to assure the long-term existance of all island species and ecosystems. Protecting species can reduce the direct loss of plants and animals to humans, but does not assure their habitat or their survival against competition from introduced species. Where introduced species are a problem, they may need to be controlled or eradicated all over the island or at least in the most sensitive areas. If the habitat or food supply is inadequate to assure a species' survival, further habitat may need to be created or food sources provided.

On small islands it is often not possible to maintain an adequate physical separation between damaging human activities and natural systems, as is done in continental areas. Activities that are incompatible with the survival of species and ecosystems may simply have to be avoided or prohibited. For instance, the risk of accidental damage may need to be reduced by controlling the importation and use of pesticides and other toxic chemicals, and certain types of industrial development may need to be limited or prohibited for the same reasons. More basically, the development desires of the people must be kept within the limits of what the island and its natural systems can support.

SUMMARY: CONSTRAINTS AND OPPORTUNITIES

The establishment of protected areas in the U.S.-affiliated islands can make important contributions to the sustainable use of renewable resources, but several constraints must be overcome to achieve this.

--- Island ecosystems and species are particularly vulnerable, requiring more scientific knowledge, more careful protection, and sometimes more active management than in other parts of the world.

--- The responsibility for the protection of many endemic species and unique ecosystems must be borne by small populations with very limited trained manpower, often weak local institutions and political structures, and little money. In addition, the small island governments cannot cope with the elaborate procedures and requirements to which large governments are accustomed.

--- Development and population growth increase the demands for limited island resources at the same time that the productive resource base is diminishing from overuse and misuse. Basic human needs often clash with the essential requirements for conservation, and conservation usually loses out. On some islands only fragments of natural areas remain, and many species are endangered.

--- There is little information available on the dynamics of island systems that would allow a clear determination of what level of resource use is sustainable.

--- Protected areas as evolved in large developed countries are seldom appropriate on small islands; the concepts must be modified to suit local cultural and ecological requirements.

--- Island people forced to give up their land or resource uses for conservation cannot easily find other land or resources when all island space is already occupied. Furthermore, nothing can replace the deep cultural and spiritual ties to ancestral lands.

At the same time, islands do present some special opportunities for the use of protected areas.

--- Many island people still live close to their environment and remember the wisdom of their ancestors in managing resources. With education they can come to see the need for protected areas and other conservation measures to preserve their island heritage. It should then be possible to get them to support and contribute to protected area establishment and to participate in protected area management.

--- The small size of islands makes it easier to study them as complete systems, and should thus make it possible to integrate protected areas into the comprehensive management of island resources.

--- Simpler solutions to many problems are possible in small island communities.

--- New technologies like remote sensing and simple monitoring by non-specialists should permit more rapid studies of the condition of resources and protected areas with immediate feedback into local resource management.

U.S. Federal agencies

The small number of protected areas in the U.S.-affiliated islands would suggest that the Federal agencies responsible for establishing protected areas have not been very active or effective in the islands. Part of the problem is the difficulty of adapting the requirements in American law concerning the different types of protected areas to the situations prevailing in the smaller islands. The primary responsibility may also have been left with local governments who have had neither the expertise nor the means to pursue the creation of protected areas. The newer more flexible types of protected area such as the National Marine Sanctuary Programme may prove easier to adapt to island needs. U.S. provisions for protected areas also lack a strong role for local people in planning and management such as would be necessary in many island situations.

Objectives for congressional action

Most U.S. legislation is too complex and its requirements are too rigid for the smaller U.S.-affiliated islands. Application of such laws to the islands can sometimes be a disservice and a hindrance rather than a help, requiring massive paperwork from scarce local staff who then have no time to do their real jobs. Some procedure should be developed allowing the small islands to observe the spirit of the law without necessarily being obliged to follow the letter.

With reference to protected areas and other conservation measures, more appropriate types of protected areas should be defined in law for implementation at the local level with Federal assistance as appropriate. Island governments should be given as much autonomy as possible in the creation and management of protected areas.

All the Federal agencies with responsibilities for conservation should be encouraged to establish special programs of technical assistance to local island governments. The most effective protected area programmes in other island countries have all been started with the help of experienced parks and reserves personnel seconded for periods of one year or more to work along side and train local counterparts in the launching of protected area programs. Opportunities could also be created for island conservation staff to receive a few months of practical on-the-job training in U.S. protected areas.

The United States is seen as responsible to the international community for protecting the genetic heritage of endemic and endangered species in the U.S.-affiliated islands. It should therefore provide incentives and financial support for island government actions in this area. Federal efforts need to be sensitive to the fact that effective protection requires local initiatives and public support, while the economic burden of that protection should not and cannot be borne only by the local people.

Given the strength of American science, the lack of basic scientific information on many aspects of the U.S.-affiliated islands is an embarrassment. Much of what has been done has been mission-oriented work by commercial firms under contract to Federal agencies, and such work seldom addresses the most basic issues. More scientists should be encouraged to work on priority problems of interest to the islands, such as the dynamics of island ecosystems, island carrying capacity, the sustainable levels of resource use, and the status and protection requirements of island species and ecosystems. This may require a special program of research grants for work in the U.S.-affiliated islands to offset the especially high costs of travel to and work in such areas.

Educational efforts to improve local understanding and appreciation of island species and ecosystems are an essential foundation for any successful protected area program, yet local island governments lack the expertise and technical means for such activities, and the non-governmental organizations that make the major effort in this field in the U.S. are weak or non-existent in the islands. Congressional action might help to foster the development of educational programs for the schools and the public based on local island situations in each U.S.-affiliated island territory. Local relevance is essential to the effectiveness of such activities.

Accession by the United States to the Convention on Conservation of Nature in the South Pacific (concluded in Apia in 1976) on behalf of the U.S.-affiliated islands in the Pacific would open the door to closer cooperation in conservation matters with other Pacific Islands with similar problems.

Institutional actions

International organizations. The International Union for Conservation of Nature and Natural Resources (IUCN) can draw on a vast quantity of information and the extensive experience of its world-wide network in identifying priorities and suitable approaches for conservation action. Its help should be called on when needed. Where trade in endangered species is involved, the Convention on International Trade in Endangered Species (CITES) provides a mechanism for action.

Regional organizations. The South Pacific Regional Environment Programme (SPREP) at the South Pacific Commission is one of the UNEP Regional Seas programs, providing assistance to all island governments in the Pacific in various environmental fields including protected areas. It would be the best single source for regional experience with practical problems, and can provide considerable assistance with appropriate educational programs. The Caribbean Regional Seas program and the Organization of American States may serve a similar role in the Caribbean, where regional non-governmental organizations are also important.

U.S. Congress. Congress should find means to modify the application of Federal legislation to be more appropriate to small tropical islands, and should see that they get the support necessary for effective conservation programmes adapted to their needs.

U.S. Federal Government agencies. The agencies with responsibilities for protected area programs (Park Service, Forest Service, Fish & Wildlife Service, NOAA) should make their practical technical experience more readily available to assist island governments. The research agencies (National Science Foundation, Smithsonian Institution, etc.) should support more research projects in the islands in collaboration with island governments. The Environmental Protection Agency should consider special standards for pesticides and other potential pollutants that are adapted to tropical conditions and island vulnerability so different from the situation in the mainland U.S.

Insular governments. The governments of the islands have the primary responsibility for resource management and the creation of protected areas on their islands, but they generally lack the expertise and finance, and often the motivation, to concentrate on what are essentially long-term goals. They must be encouraged and assisted to take a leading role in the comprehensive planning and management of island resources including the protection of island species and ecosystems. The development of a local Conservation Strategy based on the principles of the World Conservation Strategy (IUCN, 1980) could help with this. Each government should have at least one officer at a reasonably high level with specific responsibility for the long-term protection of the island's natural heritage. There is also a need for additional legislation for the creation and management of protected areas adapted to local nature conservation needs and cultural restraints. In the school system, materials on local species and ecosystems and on the need for sustainable resource use should be included in the curriculum at all levels.

Private industry. Industries must assume the responsibility for protecting the environment from their activities. Where they depend on island natural resources, they should ensure that their exploitation of renewable resources is sustainable, and that renewable resources are restored in areas where non-renewable resources have been extracted. Too often in the past, industries have profited from an island resource and then departed, leaving the island to bear the long-term costs. Where industries have land holdings or rights, they should contribute to the protection of species or critical habitats in areas under their control, and governments should if necessary provide tax concessions or other incentives for them to do so.

Academic institutions. The universities and marine laboratories in the islands should increase their research and teaching programs on island ecosystems and species and on the renewable use of resources in both the terrestrial and marine environments. These institutions would benefit from a pairing arrangement linking them to stronger U.S. universities, allowing a regular supplemental input of teaching and research staffs. A program of assistance to interested institutions to cover the extra costs of such arrangements would be a cost-effective way to strengthen research and training in the islands where it is needed the most.

Non-profit institutions. Non-profit organizations have been active in the Caribbean, where the Caribbean Conservation Association and the Eastern Caribbean Natural Areas Management Program continue to be very helpful. They have an important role in technical assistance, public education, and the development of grass roots support, and should be given every encouragement. Such institutions have not developed in the Pacific, where transportation and communications are too costly, except at a small local level. The World Wildlife Fund and other U.S. conservation organizations should be able to develop and support urgent species and ecosystem protection projects in the U.S.-affiliated islands where governments have been too slow to take the initiative.

Traditional organizations. Where traditional organizations such as councils of chiefs or elders exist, they could carry great weight in the protection of species and the identification and management of appropriate protected areas. Their understanding and support will need to be cultivated through regular and patient contact.

Impacts and consequences of the proposed actions

Islands that fail to maintain their basic renewable resources can be epitomized by Easter Island, where the pre-European population destroyed the forest, leading to soil degradation, social disruption and a great reduction in the capacity of the island to support a populaton, or Ocean Island, where the population had to be evacuated as a result of mining damage. Recent successes in education and the creation of protected areas by traditional land owners are exemplified by the wildlife management areas in Papua New Guinea (Eaton, 1985; Papua New Guinea, 1985) and the iguana reserve in Fiji (Singh, 1985). There are now about a hundred protected areas in the tropical Pacific Islands (Dahl, 1980; IUCN, 1985), but these protect less than 20% of the ecosystems in the region (Dahl, 1985b). An increase in the number of protected areas would prevent tragedies like Easter Island, where no native trees and shrubs remain (IUCN, 1985) and assure the widest range of development options for the future.

The likely consequences of the actions recommended in this paper would be a steady increase in public awareness of the need to protect island species and ecosystems, and of the scientific understanding of their requirements, accompanied by the creation of some parks, reserves and other protected areas and stronger measures for the protection of endangered species. While there would be costs associated with these actions, there is some evidence that the benefits of protected areas can far outweigh the costs (Van't Hoff, 1985) even disregarding the eventual cost of more island dependence on outside aid. There will still be some species extinctions and the disappearance of some ecosystems where the decline has already gone to far and the threatening factors (such as introduced species) are difficult to control. The broader use of protected areas for resource management will take more time to implement as the legal and institutional foundations for comprehensive island planning and management are developed and as practical experience is acquired with different management technologies. There will inevitably be conflicts between measures for the sustainable use of resources and desires for more rapid or immediate development. The resolution of those conflicts will determine whether the U.S.-affiliated islands maintain a sustainable base for their populations, or slowly decline in productivity with an inevitable increase in dependence on outside (primarily U.S.) sources of support. The outcome depends in large measure on the extent to which actions are taken rapidly along the lines recommended here.

BIBLIOGRAPHY

Bour, W., et al., "Use of High Resolution Satellite Imagery (Spot-Landsat) in the thematic mapping of three coral reefs of New Caledonia," Proceedings Fifth International Coral Reef Congress, Tahiti, 27 May-1 June 1985.

Bryan, E. H., Jr., Guide to Place Names in the Trust Territory of the Pacific Islands, Honolulu, Hawaii: Pacific Scientific Information Center, Bernice P. Bishop Museum, 1971, 411 pp.

Dahl, A. L., "Adequacy of Coverage of Protected Areas in Oceania," Proceedings Third South Pacific National Parks and Reserves Conference, Apia, Western Samoa, 24-29 June 1985b.

Dahl, A. L., "Benthic Algal Ecology in a Deep Reef and Sand Habitat off Puerto Rico," Botanica Marina 16:171-175, 1973.

Dahl, A. L., "Biogeographic aspects of Isolation in the Pacific," Ambio 13(5-6):302-305, 1984.

Dahl, A. L. Coral Reef Monitoring Handbook, Noumea, New Caledonia: South Pacific Commission, 1981, (reprinted as Reference Methods for Marine Pollution Studies No. 25, UNEP, 1984), 21 pp.

Dahl, A. L., Regional Ecosystems Survey of the South Pacific Area, Noumea, New Caledonia: South Pacific Commission Technical Paper No. 179, 1980, 99 pp.

Dahl, A. L., Traditional Environmental Management in New Caledonia: a Review of Existing Knowledge, Noumea, New Caledonia: South Pacific Regional Environment Programme, Topic Review No. 18, 1985a, 17 pp.

Dahl, A. L.; Macintyre, I. G.; and Antonius, A.; "A Comparative Survey of Coral Reef Research Sites," Atoll Research Bulletin 172:37-120, 1974.

Eaton, P., "Tenure and Taboo: Customary Rights and Conservation in the South Pacific," Proceedings Third South Pacific National Parks and Reserves Conference, Apia, Western Samoa, 24-29 June 1985.

Geoghegen, T., "Public Participation and Managed Areas in the Caribbean," Parks 10(1):12-14, 1985.

Gomez, E. D. and Yap, H. T., "Monitoring Reef Conditions," Coral Reef Management Handbook, Kenchington, R. A. and Hudson, B. E. T. (eds), Jakarta, Indonesia: UNESCO Regional Office for Science and Technology for South-East Asia, 1984, pp. 171-178.

Island Resources Foundation, Marine Environments of the Virgin Islands, Technical Supplement No. 1, Virgin Islands Planning Office, Coastal Zone Management Programme, Government of the Virgin Islands of the United States, 1977, 120 pp.

IUCN, *World Conservation Strategy*, Gland, Switzerland: International Union for Conservation of Nature and Natural Resources, 1980, n.p.

IUCN, *IUCN Directory of Protected Areas in Oceania*, Draft prepared for Third South Pacific National Parks and Reserves Conference, Apia, Western Samoa, June 1985, Cambridge, U.K.: IUCN Conservation Monitoring Centre, 1985, n.p.

Johannes, R. E., "Traditional Marine Conservation Methods in Oceania and Their Demise," *Annual Review of Ecology and Systematics*, 9:349-364, 1978.

MacArthur, R. H. and Wilson, E. O., *The Theory of Island Biogeography*, Princeton, New Jersey: Princeton University Press, 1967, 203 pp.

Newell, L., "Forestry in the American Pacific Islands and the Objectives of the World Conservation Strategy," *Proceedings Third South Pacific National Parks and Reserves Conference*, Apia, Western Samoa, 24-29 June 1985.

OTA, *Technologies to Sustain Tropical Forest Resources*, Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-F-214, 1984, 344 pp.

Papua New Guinea, "Lou Island - Landowners Managed Area," *Proceedings Third South Pacific National Parks and Reserves Conference*, Apia, Western Samoa, 24-29 June 1985.

Saenger, P.; Hegerl, E. J.; and Davie, J. D. S.; "Global Status of Mangrove Ecosystems", *The Environmentalist*, Vol. 3, Supplement No. 3, (IUCN Commission on Ecology Papers No. 3), 1983, 88 pp.

Singh, B., "Owner Involvement in Establishment of Parks," *Proceedings Third South Pacific National Parks and Reserves Conference*, Apia, Western Samoa, 24-29 June 1985.

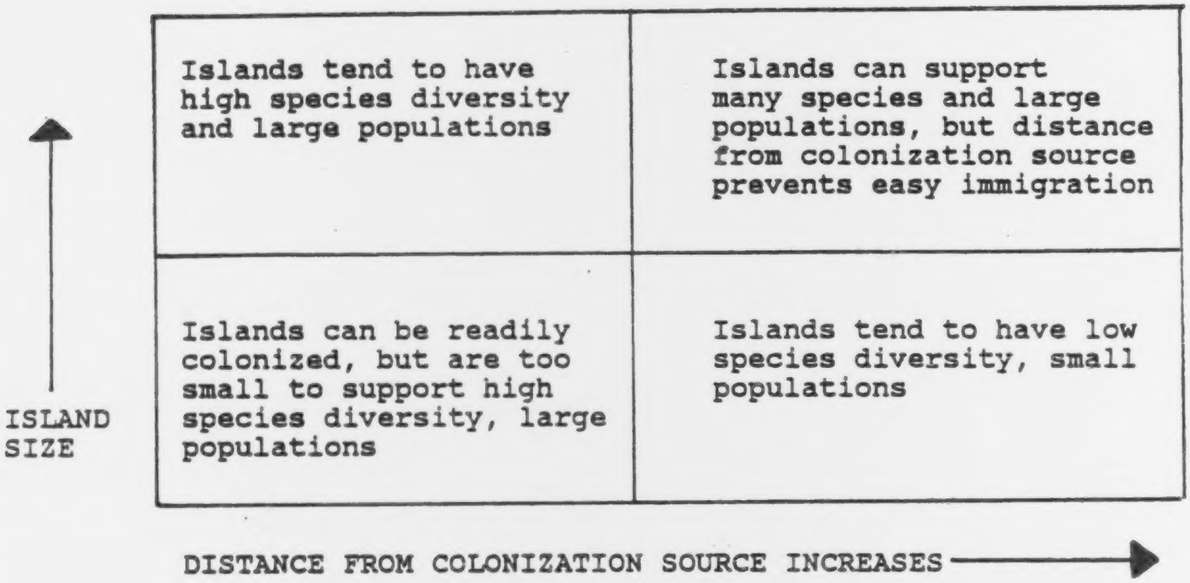
SPREP, *Proceedings Third South Pacific National Parks and Reserves Conference*, Apia, Western Samoa, 24-29 June 1985, Noumea, New Caledonia, South Pacific Regional Environment Programme.

Towle, E. L., *The Island Microcosm*, St. Thomas, U.S. Virgin Islands: Island Resources Foundation (unpublished report), April 1984, 157 pp.

Van't Hoff, T., "The economic benefits of marine parks and protected areas in the Caribbean Region," *Proceedings Fifth International Coral Reef Congress*, Tahiti, 27 May-1 June 1985.

Wass, R. C., "The Shoreline Fishery of American Samoa - Past and Present," *Ecological Aspects of Coastal Zone Management*, Munro, J. L. (ed.), Proceedings Seminar on Marine and Coastal Processes in the Pacific, Motupore Island Research Centre, July, 1980, Jakarta, Indonesia: UNESCO-ROSTSEA, 1982, pp. 51-83.

FIGURE 1


ISLAND SIZE
DISTANCE FROM COLONIZATION SOURCE INCREASES

Islands tend to have high species diversity and large populations	Islands can support many species and large populations, but distance from colonization source prevents easy immigration
Islands can be readily colonized, but are too small to support high species diversity, large populations	Islands tend to have low species diversity, small populations

Background Paper 2

CASE STUDIES OF THE IMPACTS OF INTRODUCED ANIMAL SPECIES ON RENEWABLE RESOURCES IN THE U.S.-AFFILIATED PACIFIC ISLANDS

by

Lucius G. Eldredge
University of Guam

1986

Prepared for

U.S. Congress, Office of Technology Assessment,
Integrated Renewable Resource Management for U.S. Insular Areas,
Washington D.C.: U.S. Government Printing Office, 1987.

TABLE OF CONTENTS

Introduction ....

Case Studies ....

Giant African Snail and its Predators ....

Trochus or Top Shells ....

Marine Toad ....

Selected Freshwater Fishes: Tilapia, Mosquitofish Topminnows ....

Birds ....

Mammals ....

Lessons ....

Guidelines ....

Summary ....

Literature Cited ....

ABSTRACT

A wide variety of animals have been transported throughout the Pacific islands. Case studies of selected species, exclusive of insects, show that this introduction usually has a negative impact on the islands. There are virtually no example of long-term beneficial impact from introduced animals. Fishery and aquaculture organism are known to escape confiniment and enter the natural ecosystem. Animals brought in for hunting have become pests, and biological control agents are known to caused extinctions of native species. Among the examples with initial negative effect are the Giant African snail and the toad which have each become public health problems, causing human deaths in extreme cases. Many introduced animals--snails, snakes, birds, cats--are known to have brought about the extinction of native species. Vegetation has been altered by larger animals such as deer and goats. Following an introduction, a number of case studies are detailed with a history of the introduction, along with the organisms present stations, impact, and lessons learned. These lessons are collated into a single intergrated guidelines for introduction of animals.

INTRODUCTION

The islands of Micronesia and American Samoa originally had few native land vertebrates other than a handful of bird species. The majority of the fauna has been either accidentally or intentionally introduced. Little documentation exists, and what is available is primarily anecdotal or drawn from local reports; however, there is some broad-based review literature.

Most introductions are known to have caused a number of disturbances; some have lead to widespread extinctions. Man has been responsible for most of these extinctions. Of the approximately 4,200 mammals species recognized, 88 continental and 33 insular species have become extinct since 1600 A.D. For the birds, 155 of the known 177 species extinctions have occurred within island populations (Diamond, 1984). Introduced predators are responsible for half of these insular extinctions. Rats are known to have caused the extinction of birds on some 26 islands.

Mammals have been taken to a wide variety of international locations. Along with rodents, feral species have carried a number of diseases and parasites (de Vos et al., 1956). Lachner et al. (1970) outlined the introductions of aquatic animals into North America and Hawaii. More specifically, Maciolek (1984) reported on the fish transported throughout all the Pacific islands, and Eldredge (in press) identified the introduction of marine species to tropical coral-reef areas of the world.

Introduced animals and their impacts have been reported for selected Pacific island areas--southwestern Pacific (Wodzicki, 1973), New Zealand offshore islands (Knox, 1973), Fiji (Pernetta and Watling, 1978), Papua New Guinea (Pernetta, 1982), and southern oceanic islands (Holdgate and Wace, 1971). Concern has been demoustrated at a variety of governmental levels about the continued introduction of animals and their impacts. U.S. President Jimmy Carter signed Executive Order 11987 entitled "Exotic Organisms" on May 24, 1977 [Federal Register 42(101)]. The order was intended to "restrict the introduction of exotic species into the natural ecosystems of land and waters which they own, lease, or hold for purposes of administration;..." The effects of this executive order is unknown.

More recently in 1984, the International Union for the Conservation of Nature (IUCN) drafted a statement on the "Translocation of living organisms; introduction, re-introductions, and re-stocking." This document suggests the formulation of national policies on the movement of animal species. Further, international recognization of these problems is suggested, and it is added existing international agreements be enforced. Regional plans are urged, and suggested research is noted.

For the Micronesian and American Samoan islands, little information has been documented about their introduced animals. The major species known are briefy discussed herein. Lessons learned from each situation are noted within each case study. Both beneficial and adverse impacts can be stated for some introductions. In general, most introduced species have had a negative impact on islands. The lessons which were noted individually are summarized at the end of the case studies in an attempt to explain the background behind the suggested guidelines.

Giant African Snail and its Predators

Initially considered to be an "edible snail," individual giant African snails, Achatina fulica, were grown in Taiwan the early 1930s from twelve specimens imported to Taipei in April 1933. From these, specimens were taken to Japan and then to Micronesia (Esaki and Takahashi, 1942). By 1935 importation into Japan was prohibited and restrictions were established in their commerce (Asami, 1943). Both Esaki and Takahashi (1942) and Asami (1943) documented one of the first introductions of A. fulica into Micronesia. A Mr. Shoichi Nishimura brought snails to Palau (May 1938) from Hiroshima. In November 1938 a flood washed the breeding stock from along the Garumisukan (now Ngardok) River to the lowlands. Breeding was also being conducted in Koror. On February 13, 1940, the Mayor of Palau issued an order to stop rearing snails and encouraged residents to destroy them (Asami, 1943). In September 1940, 150 youths were recruited to exterminate snails.

Snails were introduced to Saipan, Tinian, and Rota between 1936 and 1938 (Mead, 1961). During the summer of 1939, T. Esaki found snails at Ponape (Esaki and Takahashi, 1942) and warned the distict officers of the problem. Snails were taken to Pagan in 1939 where they were raised for medicinal purposes (Kondo, 1950). They were apparently also taken to Aguijan during this time, although no published record seems to exist. The other Mariana Islands appear free of A. fulica.

The first specimens recorded from Guam were found in late 1945 (Mead, 1961). [Additionally, Baker (1946) reported that R.T. Abbott had discovered a small colony on Guam in 1945.] Mead (1961) quoted a long-term Guam resident as saying, "snails first made their appearance in Guam in 1943 when the Japanese shipped into Guam sweet potatoes from Rota island." As a result of the U.S. Economic Survey of Micronesia, Townes (1946) reported that A. fulica was abundant on Saipan, Tinian, Rota, Koror, Ponape, southern Babelthuap, Peleliu, and part of Truk (Dublon). He added that there were small colonies on Guam which should be eradicated. The addition of Truk to this list probably was a result of the health resorts on that island. From Dublon, snails were taken (presumably by the Japanese) to Moen and Romalum prior to 1945; they were first recorded at Uman, Sapata, and Fefan in 1948.

Even though snails have been found at Yap, they have been successfully eradicated by careful control at entry and by collection of specimens. Yap remains free of snails (Falanruw, pers. com.), as does its outer islands, Kosrae, the atolls of Ponape and of the Marshall Islands, and many of the isolated islands of Palau (Meade, 1979).

In American Samoa, A. fulica was first seen in May 1977 near the fish canneries at Tutuila. They may have been brought as food by oriental commercial fishermen (Lauofa, pers. comm.). During 1977 and 1978, A. fulica had moved over much of Tutuila. In mid-1977 more than one million specimens were hand collected. Between January and August 1980, approximately 135 tons or more than five million snails were collected by 300 workers (Lauofa, pers. comm.). Specimens were found at Manu'a but all were successfully destroyed. None has been reported from Aunu'u.

Predators: In an effort to control the giant African snail, the Pacific Science Board (U.S. National Research Council) began investigating biological control animals. A number of animals were suggested. These included the marine toad (Bufo marinus), a variety of insects and hermit crabs, birds, reptiles (Varanus sp.), and snails. Mead (1961) reviewed all of these, as well as control through chemical means, human uses, and legislative action. Predatory snails appeared to be the most promising biological control agent.

Experments suggested that Gonaxis kibweziensis would be a good candidate for African snail control. In 1948, specimens were sent to Honolulu for laboratory testing. Meanwhile, a suitable release site was being investigated. In 1950 the Insect Control Committee for Micronesia (ICCM) of the Pacific Science Board decided that Aguijan (Mariana Islands) would be selected for field testing. On May 27, 1950, some 545 predatory snails were received from east Africa (Abbott, 1951). Following examination at Guam, approximately 400 were released on May 31 of the same year at a site along the southwest coast of Aguijan (Owen, 1950). In August 1951, Owen returned and determined that the snails had survived and had spread. A year later Kondo (1952) observed that G. kibweziensis actually fed on A. fulica. The original release had increased to 21,750 individuals. The giant African snail population was estimated to be 1,122,500. Kondo (1952) noted; however, that Gonaxis appeared to have little impact on A. fulica. Additional specimens were released on the top of the island (Mead, 1961). Two surveys were conducted in 1954. No living specimens of either species were seen along the lower levels; however, they were numerous at the upper level. Gonaxis was seen "feeding on Achatina, on other Gonaxis, and on native species" (p. 2). Peterson thought that there was greater control exerted than previously suggested.

The second survey in July-August 1954 was intended to evaluate further control efforts (Davis, 1954). No specimens of Achatina were found on the lower terraces. Some were seen 2 km southeast of the original release site. On the upper terrace, a total of 80,800 Gonaxis and 37,600 Achatina was estimated. Davis (1954) calculated approximately 60 precent effectiveness. More than 500 *Gonaxis* were collected for shipment to Hawaii. Additionally, Peterson (1957) took 88 specimens to Guam. During November 1955 more than 5000 *Gonaxis* were collected at Aguijan for introduction to other islands of Micronesia (Truk, Ponape, Palau), to Hawaii, and to California.

Thirty years later, a University of Guam group was granted a two-day visit to Aguijan in August 1984 (Eldredge, MS). The western end of the lower terrace was surveyed; no living *Achatina* or *Gonaxis* were observed. No dead *Gonaxis* shells were seen, although most hermit crabs carried eroded and well worn *Achatina* shells.

Gonaxis kibweziensis was introduced to American Samoa from Palau during fiscal year 1976-77 (Lai and Nakahara, 1980). They were first released near the canneries and appeared to be doing well enough to be collected and further transplanted at Tutuila (Lai and Miyahira, 1981).

Because of the small size and slow growth of *G. kibweziensis*, another species *G. quadrilateralis* was considered as a control agent. First introduced to Hawaii from east Africa in June 1957, the species appeared to be slowly adapting (Mead, 1961) and becoming a promising predator (Mead, 1979). In 1967 the first *G. quadrilateralis* were released on Guam but failed. A second, previously unreported release of 200 specimens near Barrigada and Yona took place on February 19, 1968 (Spencer, pers. comm.). Mead (1979) added that this species had been released at Palau and Saipan but did not provide dates.

A third carnivore, *Euglandina rosea* was originally collected in Florida and sent to Hawaii in 1955 (Mead, 1961). Within three year individuals had so successfully multiplied that 12,000 were collected for distribution outside

In the Mariana Islands at present, *A. fulica* populations appear to be at a very low level. Following the large, noticeable population explosion of the flatworm (*P. manokwari*) in mid-1980, *A. fulica* levels at Guam virtually disappeared. In 1985, there were scattered aggregations of varying sizes found around the island. At Tinian during a three-visit faunal survey in late 1984-early 1985, no live individuals were observed, although local residents did report very rare sightings. In August 1984 during a trip especially designed to look for snails at Aguijan, no living forms were observed (Eldredge, MS). During two visits to Pagan in 1981, none was seen at the northern inhabited portion of the island. The volcanic eruption may have further assisted in extermination (Eldredge, 1982). The current status elsewhere in Micronesia is unknown; snails do not seem to be causing problems.

In American Samoa, *A. fulica* populations, although having spread to the western end of Tutuila by May 1984 (Lauofa, pers. comm.) have decreased in number. The introduced carnivore snail, *E. rosea*, is locally considered responsible even though natural population declines have been suggested.

Impacts and Lessons:

In addition to a being general nuisance, *A. fulica* is an agricultural pest. Its economic importance is probably greatest in newly colonized areas or at the height of its expanding populations (Mead, 1979). Damage is thought to be localized.

A very important effect of the dispersal of *A. fulica* is its carrying human diseases. Among others, the African snail carries the rat lungworm *Angiostrongylus cantonensis* and the gram-negative bacterium *Aeromonas hydrophila* (Mead, 1979).

The rat lungworm produces symptoms diagnosed as eosinophilic meningoencephalitis. Alicata (1962) was the first to note report this worm in A. fulica. He further reviewed this disease in Micronesia (Alicata, 1965). Incidence was high among rats, but land crabs, coconut crabs, and freshwater prawns also had the parasite. In 1979 the first case of eosinophic meningitis was reported in American Samoa (Beck et al., 1980). The parasite was not found in local rats, but all (ten) of the African snails examined had the parasite. Infection was acquired by ingesting raw or improperly cooked snails or freshwater prawns. At least one death is known (Whitten, 1981).

Perhaps an even more important impact of A. fulica is the effect the introduced predatory snails have on native snails. These predatory snails have been responsible for the elimination or reduction in numbers of native snails in Hawaii (Hadfield and Mountain, 1981), Australia (Colman, 1977), and French Polynesia (Pointier and Blanc, 1984; Clarke et al., 1984). Arguments have appeared about the value of the introduction of predatory snails (Hadfield and Kay, 1981; Christensen, 1984). Hadfield (1984) provided convincing evidence of the extinction of the Hawaiian endemic Achatinella species.

A recent controversy erupted concerning the introduction of E. rosea into Amercian Samoa. Tutuila has thirty-three species of terrestrial snails; six are known to be endemic. With the knowledge of extinction elsewhere, several biologist protested the American Samoa Government's recommending the introduction of E. rosea (Hadfield, pers. comm., Christensen, pers. comm.). Regardless of these protests, E. rosea was brought to Tutuila where it is successfully spreading following its release near the Community College in 1980 (Lauofa, pers. comm.). Even though one story indicates that the predators have been collected, another proudly relates how the islanders are spreading them throughout for African snail control. *E. rosea* had reached the mountains by May 1984. Only time will tell the fate of the Tutuila native snail fauna.

Trochus or Top Shells

One of the best documented introductions is that of the marine top snail Trochus niloticus. The snail, valued for its shell and for its edible meat, occurs through much of the southwestern Pacific (Gail and Devambez, 1958). The status of the trochus fishery in Micronesia was summarized in detail by McGowan (1958). The current annual harvest is about 5000 tons, having a value of about $4 million (Heslinga et al., 1984).

Between 1927 and 1931, 6724 individuals were transplanted from Palau to Truk (Asano, 1937), and between 1929 and 1939, to Ponape. In March 1938, 2974 individuals were released four sites on Saipan (South Seas Government, Fisheries Experiment Station, 1939). All were placed as depths of about 30 feet. The transplantation was considered unsuccessful at the time because the death rate was 42 percent (Asano, 1938). However, a year later the remaining 2.5 inch-diameter shells had grown as much as one inch.

In 1955 Van Pel (1955a) suggested that trochus should be introduced to Guam from Saipan. He added that some had already been brought to Guam but urged that more be placed on the reefs. Information on mass transplant is nonexistment.

Individuals of trochus were taken to a number of central Caroline Islands localities where attempts were thought unsuccessful at some areas. Approximately 200 specimen were released at Kosrae in 1959 by the Economic Development Office. An unpublished 1979 survey indicated that the population was too low to support a fishery. Trochus are reported as fairly common at Ngatik, an atoll 90 miles southwest of Ponape (Zoutendyk, pers. comm.).

Van Pel (1959) also recommended that trochus be taken to American Samoa. This apparently never occurred, no individuals were seen during an extensive coral reef survey during March 1985 (Smith, pers. comm.).

Present Status and Impact:

Nothing is known of the impact of trochus on the island's shallow-water reef flats. At Guam, Smith (1979) carried out extensive field studies on growth, abundance, and distribution of the snail. He found densities as great as 2.45 ± 0.65 for $20m^{-2}$ at the outer reef flat at Tumon Bay. Some reef flats are thought to have commercially harvestable populations (Stojkovich and Smith, 1978). Truk and Ponape are thought to have populations sufficient enough to support a fishery of 150 tons annually (Parkinson, 1980). The successful trochus hatchery at Palau has not exported juveniles snails (Heslinga, pers. comm.) The Micronesian Mariculture Demonstration Center has; however, planted young giant clams (*Tridacna derasa*) an the reefs at Yap (1984), the Marshall Islands (1985), and Pohnpei and Guam (1985). The status and impact of these potentially commercial animals is yet unknown.

Marine Toad

The marine toad Bufo marinus occurs naturally between southern Texas and western Mexico to central Brazil (Zug and Zug, 1979). Individuals have been introduced throughout much of the Pacific area during the past 50 years. Because of their large size and their wide adaptability, toads were thought to be good biological control agents. Transplantation of marine toads has been reviewed most recently by Honegger (1970), Tyler (1975), and Easteal (1981).

In the Pacific area, the first toads were brought to Oahu (Hawaii) in 1932 from Puerto Rico (Pemberton, 1934). The toad was later introduced to Guam originally for insect and garden slug (Veronicella leydigi) control. Some nineteen individuals from Hawaii were released at Agana Springs in July 1937 (Anon., 1937a). By September of that year, toads were found as far as Piti, several miles to the south (Anon., 1937b). [Easteal (1981) reported from unpublished Hawaii Sugar Planter's Association information that fewer than 39 individuals were released in 1937.] In January 1938, more than 5000 young toads were collected near Piti and were transplanted in lots of 500 each to Umatac, Merizo, Inarajan, Yona, Dededo, Talofofo, and Sumay (Anon., 1938)

The first record for Micronesia outside of Guam was that from Tinian in 1944 (Stohler and Cooling, 1945). Individuals, estimated to be approximately 4000, were found in cisterns and lily ponds. Original stock arrived from Guam (Townes, 1946) during the Japanese occupation, although Downs (1948) stated that he did not know their source. Townes (1946) further added that toads were found at Saipan and at Rota, having been introduced to Rota as recently as 1944. Fisher (1948) noted that toads were abundant on Ponape and Yap. Toads were taken to Ulithi in October 1948 but were all destroyed upon arrival (Langford, 1948). [They were later introduced in 1973 (McCoy, pers. comm.).] A single toad was taken to Pagan in the mid- 1960s (Aldan, pers. comm.). Savage (1960) reported toads from Palau and studied larvae collected at Koror. Because of the many similarities between Palauan and Mexican specimens, Savage suggested that the Palau forms may have originated from the west coast of Mexico.

The toad was introduced to Tutuila, American Samoa, from Hawaii, in 1953 [although Simmonds (1957) had strongly advised against such action]. Amerson et al. (1982) provided details about the original introduction and the present status of the species, indicating that they have done more harm than good. Their introduction to Aunu'u is not documented (Amerson et al., 1982; Lauofa, pers. comm.).

Present Status:

Studies are available on the present status of Bufo marinus for Guam (Chernin, 1979) and for American Samoa (Amerson et al., 1982)

At Guam five sites--a spring with standing water, a swamp with fluctuating water, a limestone forest, a savanna, and an area of human habitation--were studied. Populations were greatest in areas of standing water and human habitation. Toads were excluded from the savanna and were found in low numbers in the limestone forest. Densities varied seasonally. During late 1978-early 1979, the population density was 185 per hectare in areas of human habitation and 225 per hectare for standing water at Agana Springs (Chernin, 1979). For human habitation this density is similar to that (184 per hectares for 1975 and 138 per hectare for 1976) found by Zug and Zug (1979) at Panama. However, they found many fewer--54 per hectare for 1975 and 84 per hectare for 1976--for areas of standing water in Panama.

On Tutuila the toad population densities were estimated at 121 per hectare (extrapolated from "per 100m^2" data) for areas near human habitation and 110 per hectare along the coastal rock strand (Amerson et al., 1982). This authors added that toads were active only at night; hiding during the daylight. Adults and tadpoles were observed during each month of the study.

Impacts and Lessons:

The consensus seems to indicate the toad introductions have been more disastrous than beneficial. This is the direct implication for American Samoa (Amerson et al., 1982).

Toads are a nuisance and have poisonous parotid glands behind the head which secrete [and can be "squirted in jets for a distance of at least one metre" (Tyler, 1975, p.3] toxins. Numerous cat and dog deaths are reported; human deaths have also been recorded (Tyler, 1975).

In American Samoa there is no direct evidence, but the high incidence of polluted drinking water and dysentary may be correlated with the high densities of toads in areas of human habitation (Amerson et al., 1982). Kourany et al. (1970) reported a high incidence of Salmonella associated with amphibians.

In a general assessment of the impact of toad introductions, Tyler (1975) noted that "in the long term the toad failed to live up to expectations." Beneficial insects were also eaten by toads and the impact on native vertebrates is not known. In addition to contaminating drinking water, toads are known to have killed fresh water, exotic fishes. The problem remains. Time magazine (July 29, 1985, p. 49) highlighted the introduction to Australia, detailing the effects of this "cold-blooded killer."

Nearly twenty-five years ago, Mead (1961, p. 105) wrote:

> Who could have guessed that introducing *B. marinus* would, in addition to reducing the black slugs, aggravate the rat problem, kill the monitor lizard, reduce natural control of coconut pests and the giant snail, bring some relief to the poultry industry, kill pigs and house pets, and ameliorate a public health problem of cockroaches and flies brought on by the introduction of giant African snails? As a final ironic twist, the native peoples are convinced that their dogs and cats have died from eating the "poisonous" giant African snails!

Additional Amphibian and Reptile Introductions:

Several other herpetofaunal species are known to have been introduced into Micronesia and American Samoa. Unfortunately, little is known about the original information and about the current status of most of these species.

Individuals of a small tree frog *Litoria glauerti* were first found in the central courtyard of the old Guam International Airport in 1968 (Falanruw, 1976). Specimens are now found throughout Guam. This frog belongs to a complex of species which occurs in the coastal areas of southern Queensland to as far south as Sydney (Zug, pers. comm.). Speculation might lead one to wonder whether the frog's arrival at Guam might not have resulted from the escape of a child's pet during an airline layover.

The green anole *Anolis carolinensis* was brought to Guam in the mid-1950s by an engineer who thought individuals would be good for insect control (Owen, pers. comm.). Brown (1965) reported in a footnote that Dr. J. L. Gessitt "states that *Anolis* is apparently established on Guam island" (p. 1481). Individuals are also known from Saipan (Aldan, pers. comm.) and from Palau and, in both localities, are assumed to have arrived from Guam (Owen, 1977b).

The green tree skink *Lamprolepis smaragdina* is found on Rota, Tinian, and Saipan. Attempted introduction of this species at Guam from Yap in the late 1960s was unsuccessful. Since this skink is common in the central Caroline Islands and since there is periodic traditional sailing canoe travel between the Carolines and the northern Marianas, it would seen that most logical that the skink arrived by canoe.

Even one of the crocodiles at Palau is said to have been intentionally brought in (Motoda, pers. comm.).

The most disasterous introduced animal on Guam is the brown tree snake *Boiga irregularis*. The potentially large snake was first seen in the late 1940s or early 1950s. Individuals spread through most of the island by the 1970s as a rate of 1.6 km per year (Savidge, pers. comm., and 1985). This snake is the major reason for the range reduction and extinction of the forest birds of Guam.

Selected Freshwater Fishes: Tilapia, Mosquitofish, Topminnows

Numerous freshwater fishes are known to have been introduced throughout the island of the Pacific. For the U.S.-affiliated islands, perhaps Guam has recorded the greatest number. A total of sixteen species has been introduced into the Mariana Islands; nine have become successfully established. Little information is known of most of these introductions; however, some species are well documented. Both exotic aquarium fishes and those brought for aquaculture are now naturalized. Maciolek (1984) reviewed the introduction of fishes into Hawaii and other Pacific islands.

Three species are detailed herein, since these forms are probably among the most well documented and most widely distributed.

Tilapia-*Oreochromis mossambicus*: Tilapia are originally an African fish which were considered to be good species for farming. Individuals were first taken to Java in 1939 and were subsequently transported and grown extensively throughout southeast Asian countries. In late 1954 the first tilapia were brought to Guam from the Philippines (DeLeon and Liming, 1956). From a small cement tank several thousand were distributed throughout Guam. [A second species, *Tilapia zilli* may have been released as 1956 at Guam.] In January 1955, 300 tilapia from Manila were released at Lake Susupe, Saipan (Anon., 1955a). A similar report indicated that the original 375 tilapia brought from the Philippines had increased to five thousand by September 1955 (Anon., 1955b). Some 200 specimens were taken to Pagan in October 1955 (Brown, 1955) and reported to have grown to an unusually large size by March 1961 (Brown, 1961). By 1957 tilapia had also been taken to Tinian and Anatahan. Recently, tilapia have been reported from Yap; however, Palau apparently remains without them (Bright and June, 1981).

Tilapia were released in the brackish lagoon at Aunu'u, American Samoa, in early 1957. From this successful introduction, some 80 fish were released in the Leme Creek on Tutuila prior to 1959 (van Pel, 1959). There are apparently no tilapia on Tutuila at present (Sesepesara, pers. comm.).

Mosquitofish - Gambusia affinis: Individuals of this fish have been introduced throughout much of the world as agents for mosquito control. During World War II the U.S. military brought mosquitofish to several island groups in the Pacific, including the Mariana and Caroline Islands and Samoa (Krumholz, 1948). Individuals were well established in Fena Resevoir, Guam, by 1955 (Brock and Yamaguchi, 1955). Additionally, individuals were taken to Pagan around 1955 and are now well established in both lakes. Maciolek (1984) reported G. affinis from Ponape. Nelson and Cushing (1982) noted the fish from the brackish lake at Pulusuk, Truk State, and indicated that individuals were brought from Truk in the 1960s.

Topminnows-Several species: An undetermined species of topminnow was brought from Japan to Saipan and Palau in 1939. A total of 170 fish were purchased in Tokyo and carried in small tub to Saipan. Only about 5 died en route; some 50 were further carried to Palau (Ikebe, 1939). A number of other fish were taken to Palau in 1939 (Kato, 1940). Among them, the "medaka" was used as an experimental example for fish transport.

At Guam, Poecilia reticulata was first introduced into Fena Resevoir in 1956 (Brock and Takata, 1956). P. latipinna and Xiphophorus helleri were later introduced and are now established (Shepard and Myers, 1981). These authors listed a total of nine introduced freshwater fishes. Bright and June

(1981) provided information on the freshwater fishes of Palau and noted that four species--*Poecilia retculata*, *Xiphophorus maculatus*, *Puntius sealei*, and *Misgurnus anguillicaudatus*--were considered introductions.

At American Samoa specimens of topminnow, presumably *Poecilia mexicana* were originally introduced in the late 1920s by the Department of Health for mosquito control (Sesepesara, pers. comm.). In the 1930s topminnows (also called mollies) were considered to be a candidate for use as baitfish when natural baitfish populations were low (Baldwin, 1977). Additional species have been tested for baitfish use, especially *P. vittata*. Large-scale trials (Vergne et al., 1978) and live bait testing (Lambert and Bryan, 1979) have been attempted at American Samoa. In June 1979, some 12,000 baitfish held at the airport lagoon escaped following vandalism. None was recaptured. Both species are reportedly found in the streams on Tutuila (U.S. Army Corps of Engineers, 1981).

Marine species: There are few examples of marine fish introductions in the Pacific. Marquesan sardines were released in Hawaii during the late 1950s (Brock, 1960). Three species of jacks, a bonefish, a goatfish, and a mullet were accidentally introduced at the same time (Randall and Kanayama, 1972). This smaller mullet (*Chelon engeli*) negatively impacted the existing mullet (*Mugil cephalus*) fishery, comprising about 80 percent of the mullets collected in estuaries an Kauai between 1975 and 1978. The goatfish also appears to have become established.

Ten species of deep-water snappers (lutjanids) and groupers (serranids) were introduced to Hawaii from French Polynesia between 1956 and 1961. Three have become established (Randall, 1980), and ecological studies have been conducted (Oda and Parrish, 1982). The species have spread widely throughout the islands and are either displacing or competing successfully with the more desirable native species.

Impacts and Lessons:

Quantitative studies on the impacts of these fish (and others) are virtually nonexistent. Introduced fishes are known to have some beneficial aspects. Reservoir water-weed control was successful as Guam. Mosquito control has also been successful in numerous island areas. Additionally, there has been limited success with introduced species for bait or human food. Unfortunately, in almost all these cases, individuals have "escaped" and become naturalized in local streams. Tilapia are now found in marine waters where they are known to breed at Fanning Island (Lobel, 1980) and where they have become the most predominate fish at the Ala Wai Boat Harbor, Hawaii (Kinsey, pers. comm.)

In general, introduced freshwater fishes have had a major effect on streams. Native island stream animals spend part of their life cycle in the ocean, usually entering the stream during their postlarval stages. Maciolek (1984) stated the he suspected that predation on the native fauna was more significant than competition. Another problem of transporting fish to new areas is the introduction of new parasites or diseases, although no examples are known for the Pacific islands.

Among the possible solutions to exotic naturalization are the introduction of monosex populations or sterile hybrids. The "cherry snapper" is a hybrid tilapia (O. mossambicus and O. niloticus) developed in Taiwan and introduced into Guam in 1973 (Anon., 1983). About 85 percent are male (Lovshin, 1982).

Although primarily written for North American fish, Lachner et al. (1970) discussed numerous species in detail and presented guidelines and recommendations for animal introductions. These are presented in detail herein later in relation to the overall problem of introduced species.

Birds

Birds are among the most commonly introduced animals. Historically, they been on part of man's activities since early times and have been intentionally and accidentally released in numerous locations. Recently, a major compilation outlined the records of birds introduced throughtout the world (Long, 1981).

Fortunately, few foreign birds have actually become established in Micronesia and American Samoa. Unfortunately, little information exists about these species and virtually nothing is known of the effect of these birds. "No Micronesian bird has even been the subject of an intensive study" (Jenkins, 1983, p. 1).

Fourteen species have been introduced to Guam. Jenkins (1983) stated that seven were established. The red junglefowl (*Gallus gallus*) is known to be established on other islands in the Marianas (Owen, 1977a). Intentionally introduced but unsuccessful species include the gray francolin (*Francolinius pondicerianus*), spotted tinamou (*Nothura maculosa*), and red-winged tinamou (*Rhynchotus rufescens*) (Aquatic and Wildlife Resources, 1977).

The Philippine turtle dove (*Streptopelia bitorquata dusimieri*) was introduced from the Philippines in 1771 (Baker, 1951). Individuals are now found on Rota, Tinian, and Saipan and are considered to be the most important game bird of the islands (Perez, 1970). A two-year moratorium on hunting on Guam was begun during 1985. The drongo (*Dicrurus macrocercus*) was originally brought to Rota from Taiwan 1935 (Baker, 1951) and was first reported from Guam in 1960 (Hartin, 1961). The Java sparrow (*Padda oryzivora*) was once established but disappeared (following Typhoon Karen) in 1962 (Owen, 1977).

Five exotic species are reported at Palau and two at Yap. Red jungefowl and the scaly-breasted mannikan are known from both islands. Two species of psittacids--sulphur-crested cockatoo (*Cacatua galerita*) and eclectus parrott (*Eclectus roratus*)--are probably established and breeding at Palau (Ripley, 1951; Forshaw, 1973). The house sparrow (*Passer domesticus*) and the tree sparrow (*P. montanus*) have become established in the Marshall Islands (Temme, 1985), and the common myna (*Acridotheres tristis*) was once established at Kawajalein (Owen, 1977a).

Of the two introduced species--rock pigeon (*Columba livia*) and red-vented bulbul (*Pycnonotus cafer*)--in American Samoa, only the latter is well established (Amerson et al., 1982). The rock pigeons are the survivors of a small flock which originally lived in the Pago Pago Harbor area in the 1950s. The red-vented bulbul first appeared sometime after 1957 (1958 of Muse and Muse, 1982). The birds are common around villages on Tutuila (Amerson et al., 1982).

Impacts and Lessons:

Birds are intentionally introduced for a number of reasons (Long, 1981). Among these are aesthetics, food, hunting, sport, and pest control. There are numerous record of birds escaping from cages or enclosures. Problems are brought about through introductions. Exotic species can be threat to native species through competition, predation, or the introductions of diseases and parasites. Newly introduced birds may hybridize with native species. Of major importance is the possibility of agriculture damage brought about by introduced birds.

For the Pacific islands few examples demonstrate each of the benefits or disadvantages of these introductions. The Hawaiian Islands record the greatest number of bird introductions. Approximately 162 species have been brought to the islands; more than 70 have become established (Long, 1981). Unless measures are taken to control the continued introduction, there will be greater problems in the future. Future bird introductions to Micronesia and American Samoa should be restricted.

Mammals

The only truly native land mammals on Pacific islands are bats. A number of other mammals here been taken to the islands both accidentally and intentionally, recently and historically. The colonizing islanders may have carried rats and pigs, and dogs were known at Ponape upon European contact.

Small rodents (Johnson, 1962) are among the most transported species. The Polynesian rat (Rattus exulans) is found commonly throughout Micronesia and American Samoa and in generally thought to have been introduced prior to European contact (Williams, 1973). This rat is sometimes a serious agricultural pest. The roof rat (Rattus rattus) is also widespread throughout Micronesia (Johnson, 1962) and throught to be a recent introduction to American Samoa (Amerson et al., 1982) where is considered uncommon. The Norway rat (Rattus norvegicus) is also a fairly recent introduction to the entire area. Specimens were found on Saipan and Ponape and at Koror following World War II (Marshall, 1962a). The first record from Guam was the collection of specimens in May 1962 (Barbeheen, 1974). The Norway rat remains to be uncommon. No specimens were observed in American Samoa, although there had been previous records (Amerson et al., 1982). Perhaps, the species no longer occurs there.

The house mouse (Mus musculus) has been found throughout Micronesia (Marshall, 1962b) and is rare at Tutuila, American Samoa (Amerson et al., 1982). Although Marshall (1962b) indicated they are absent from atolls, house mice are found at Enewetak Atoll, Marshall Islands (Berry and Jackson, 1979). They suggest that escaped laboratory mice may have originated or contributed to the present population.

The musk shrew (Suncus murinus) was first collected on Guam in May 1953 (Peterson, 1956). Individuals probably arrived from the Philippines. Within two years specimens were found as far away as 20 miles from the original location. Since 1956 the shrew had moved throughout the island and become relatively as common as the local rodents (Barbebeen, 1962). The shrew population continued to expand. Between 1958 and 1969 the number of trapped house mice declined, apparently the result of the shrew's introduction (Barbeheen, 1974). The musk shrew was first been on Saipan in August 1962, Rota in September 1966, and Truk in September 1967 (Barbeheen, 1974). Two independent sightings each of an individual specimen on Palau have been noted (Barbeheen, 1974; Owen, 1977b). Specimen are reported herein for the first time from Tinian and one was seen at Guguan in 1984. Shrews are known to kill baby chickens and were considered a possible problem for Guam's flightess rail, although no evidence has been demonstrated. House mouse populations did decrease during the expansion of the shew, but there is no direct evidence that shrews were the cause. Individual shrews can be a household nuisance.

The Sambar deer (Cervus unicolor) was introduced from the Philippines in 1771 by Governor Mariano Tobias (Safford, 1905). Although the original purpose is not known, deer were hunted within a few years. Individuals were established by 1774 and by 1819 ranged extensively on the island (Quoy and Gaimard, 1824). Several were taken to Rota and fenced on the Taipingot Peninsula (Prowazek, 1913), and they were later taken to Saipan (Schnee, 1912). The deer were taken to Ponape at an unknown time but specimens collected in 1939 were reported (Shikama, 1942). At present the deer is found throughout the island of Guam; however the greatest number are found within restricted military areas. Information on distribution, population trends, and biology for the eighteen-year period between 1961 and 1978 are detailed by Wheeler (1979).

A number of other mammals are known to have been brought to the islands. The carabao has been on Guam since the late 1700s. Documentation on the orginal introduction has not been located. Carabao are presently on Ponape (Gawel, pers. comm.) and are known from Palau (Owen, 1977b). Feral cats, dogs, and pigs are found throughout the islands. A monkey, the crab-eating macque, was accidentally introduced to Angaur (Palau) in the early 1900s (Owen, 1977). The impacts of these mammals are not well documented. A goat introduction program has been initiated by the United Nations at Pohnpei (King, 1985) but nothing is presently known about this project.

LESSONS

Lessons learned from the introduction of exotic animals into new environments can be broadly categorized as having either beneficial or adverse impacts. Additionally, there are a number of instances of unknown impact.

Within the U.S.-affiliated islands there are virtually no examples of long-term beneficial impact from introduced animals. Potentially commercial fisheries may result from the introduction of the marine animals--trochus and tridacna. Unfortunately, nothing is known of the impacts of these animals, and tridacna have only recently (during 1984 and 1985) been transported in Micronesia. Aquaculture potential has been demonstrated for certain fishes and crustaceans; however, there has not yet been shown to be a real economic benefit from them, and a number of examples of escape of these animals in known. Baitfish raised at American Samoa were released and never shown to be economically viable.

The original reason for bringing the deer and the Philippine turtle dove of Guam is unknown, but hunting has been suggested. In the mid-nineteenth century the deer did contribute significantly to food supply for the Spanish garrison. At present, deer hunting is a recreational sport controlled by the Government of Guam. The Philippine turtle dove was, at one time, the most heavily hunted game bird, but a two-year moratorium is now in effect at Guam.

Animals introduced as biological control agents were initially successful; however, long-term evidence has not substantiated this. The toad became a greater pest than benefit. The topminnow taken to American Samoa for mosquito control have now replaced local fishes in the streams. Nothing is known of the drongo brought to Rota for insect control and now found also at

Guam. Fishes were originally successful in aquatic weed control in such places at Fena Reservoir, Guam, but later escaped into local streams.

Birds transported for aesthetics into Hawaii have not shown to be particularly beneficial even though they have been reasonably successful. No similiar examples are known from the U.S.-affiliated islands.

Most examples of animals introduced to new geographic areas bring about negative or adverse impacts. Prime among these are agricultural and public health problems. The African snail is among the most important agricultural pests because of its severe economic impact by feeding on cultivated plants. In some areas the snail is known to denude large areas in very short periods of time. Additional agricultural pests include rats feeding on plants and processed foods and birds feeding on plants, especially fruits.

Foremost among public health pests are African snails and toads which, in extreme cases have known to cause human deaths. The rat lungworm parasitizes the African snail and has been recognized as the cause of cerebral angiostrongylosis in humans. The consumption of raw on improperly cooked snails is the transmission route. Human and animal deaths have been reported following the consumption of toads. Circumstantial evidence indicates that there are increased salmonella outbreaks in areas of large toad populations. Rats, birds, and fish are known to carry new human and animal parasites into new geographic areas.

Another important negative impact is the extinction of native animals by introduced ones. Predatory snails are known to cause the extinction of native snails in Hawaii, French Polynesia, and Australia. The brown tree snake is thought to be the cause of the extinction of a number of Guam bird species, and cats are thought to have caused similiar bird extinctions, although there is no direct evidence.

Vegetation has been greatly altered by introduced goats and pigs. Although there have been no studies in the U.S.-affiliated islands, evidence from Hawaii and Fiji indicate real potential problems.

Many introduced animals are considered to be of a high nuisance level. Road-killed toads and snail droppings attracts flies, shrews builds small residences, and toads consume beneficial insects and biological control agents. Nuisance levels differ from locality to locality.

The impact of a number of animals is unknown. Unfortunately, studies have not been conducted on trochus or tridacna introduction. Nothing is known about the impact of the anole or the green tree skink, as well as the impact of released freshwater aquarium fishes.

GUIDELINES

Great care should be taken when any exotic species is being considered for introduction. The biology and life history of the species to be introduced must be known. The individuals to be introduced should be examined to insure that parasites or diseases are not introduced. Each individual released should be identified as the species to be introduced so that undesirable species are not introduced inadvertently.

Introduced individuals should be held in quarantine or in observation tanks to prevent the further introduction of disease or pest species from being introduced. Only healthy organisms should be released.

Sterile hybirds should be considered for introduction. The "cherry snapper" is a hybird (cross between Oreochromis mossambicus and O. niloticus) tilapia developed for bond culture and popular in Taiwan. About 85% of the hybird are male (Lovshin, 1982).

Large scale intentional introductions could alter the natural population in much the same way that Vermeij (1978) suggested could happen during biotic mixing. There might be no interaction; there might be hybirdization and evolution.

Courtenay and Robin (1973) suggested that "good intentions provide poor grounds for introducing exotic animals" and presented seven steps to be considered in order to prevent disastrous results.

1. The reason for the introduction should be clearly stated and demonstrated.
2. A search for introduction candidates should be proposed, listing favorable and unfavorable aspects of each candidate.

3. An assessment of the alien species impact should be considered. This should include impact on the overall ecology, edibility and catchability and public health aspects. (For coral-reef associated fishes this should include background information on the species and with ciguatoxin). The impact of the introduced species which has become established in a non-native area should be most helpful.
4. The introduction should be widely publicized and should be reviewed by a panel of specialists.
5. Experiments with the species being considered should be conducted, especially in escape-proof systems.
6. The report prepared should be publicized and evaluated by all governmental and private groups involved, particularly regional (or international where multi-national islands are involved).
7. After favorable review the species could be released.

Additionally, Li and Moyle (1981) proposed screening "rules" developed by entomologists but modified for fisheries management. They added four criteria pertinent to the introduction itself. They illustrated their study with "loop analysis" case histories of two lake systems. Perhaps the same work is applicable to tropical insular studies.

Kohler (1981) proposed a protocol which included four evaluation levels. The goal of this "review and decision model" is designed to "ensure that exotics are used in the wisest manner." The feasibility of the introduction should be considered, and the habitat requirements should be known. If at a later time the introduction is considered undesirable, he added that some control methods might be implemented.

Even after following these proposed steps, monitoring should be continued in order to establish the degree of success of the alien species. Randall and Kanayama (1972) have aptly summed up the problem of alien species: "Once and organism has become established in the marine environment, the new locality will probably have to live with it for as long as man survives on this planet."

SUMMARY

Considering that almost all the vertebrate animals other than a few bird species were at one time introduced to the Pacific islands, it is amazing that there have not been greater and more devasting impacts. Probably the most significant effect on an island is the high rate of bird extinctions currently occurring at Guam. The recent accidental introduction of the brown tree snake is thought to be the cause. Another example is the potential extinction of native land snails in American Samoa brought about by the introduction of predatory snails.

Action should be taken to control the introduction of exotic species. Local legislation and its enforcement would be the most direct route to control the transportation of potentially disasterous species. The key would be local enforcement. Numerous examples could be given throughout the Pacific where legislation exists but is ignored. The local governments could be assisted by appropriate Federal government agencies, such as the Fish and Wildlife Service, Environmental Protection Agency, National Marine Fisheries Service, the Department of Agriculture, and so forth. Each agency has its own objective which could be extended to the complimentary local office. Academic intitutions and nonprofit organizations could assist as an information resource, but the basic "grass roots" approach would be local enforcement. This is best supported through extensive educational programs demonstrating the pros and cons of exotic organisms.

In order to achieve this, funds need to be provided for basis research of local organisms and their ecology with and without the problems of introduced species. Inventories need to be made prior to introduction to investigate native (endemic) species. Research needs to conducted on exotic species in an attempt to understand their biology and their protential impact on the native fauna.

Additionally, funds need to be provided for public education programs. Specific types of literature need to be produced for different levels of instruction from formalized schooling to newspaper advertizements. And this need to be done in a variety of languages.

Further support is needed for the organization of local screening committees to investigate and enforce proposed species introduction.

PERSONAL COMMUNICATIONS

Ben Aldan, Coastal Coordinator (and long-term resident of Pagan) for Northern Islands, Coastal Resources Management Office, Saipan, CNMI (August 1984)

Carl C. Christensen, Malacologist, B. P. Bishop Museum, Honolulu, Hawaii (December 1984)

Michael G. Hadfield, Professor Pacific Biomedical Research Center, University of Hawaii, Ahui Street, Honolulu, Hawaii (numerous occasions)

Gerald A. Heslinga, Micronesian Mariculture Demonstration Center, Palau (August 1985)

Robert A. Kinsey, Professor, Department of Zoology, University of Hawaii, Honolulu, Hawaii (numerous occasions)

Ta'ala Lauofa, Director, Department of Agriculture, Government of American Samoa, Pago Pago, American Samoa (May 1984)

Sigero Motoda, College of Fisheries, Tokai University, Shirohama, Japan (December 1986)

Michael McCoy, Executive Director, Maritime Authority, Federated States of Micronesia, Ponape, FSM (numerous occasions)

Robert P. Owen, Staff Conservationist (Retired), TTPI, Palau (Currently resident of Seattle, Washington) (January 1984, December 1985)

Julie Savidge, Wildlife Biologist, Aquatic and Wildlife Resources Division, Department of Agriculture, Agana, Guam (October 1985)

Henry Sesepasara, Director, Office of Marine Resources, Government of American Samoa, Pago Pago, American Samoa (May 1984)

Barry D. Smith, Sea Grant Extension Agent, Marine Laboratory, University of Guam, Mangilao, Guam (numerous occasions)

Neal Spenser, Entomologist, Department of Agriculture, Agana, Guam (February 1968)

David Zoutendyk, Peace Corps Volunteer (Marine Resources), Ngatik Atoll, Ponape, FSM (August 1985)

George R. Zug, Curator, Department of Zoology, Smithsonian Institution, National Museum of Natural History, Washington, D.C. (November 1983)

LITERATURE CITED

Abbott, R. T., "Operation Snailfolk," Natural History 60:280-285, 1951.

Alicata, J. E., "Angiostrongylus cantonensis (Nematoda: Metastronglidae) as a Causative Agent of Eosinophyilic Meningitis of Man in Hawaii and Tahiti," Canadian Journal of Zoology 40:5-8, 1962.

Alicata, J. E., "Notes and Observations on Murine Angiostrongylosis and Eosinophilic Meningoencephalitis in Micronesia," Canadian Journal of Zoology 43: 667-672, 1965.

Amerson, B. A., Jr.; Whistler, W. A.; and Schwaner, T. D., "Wildlife and Wildlife Habitat of American Samoa. II. Accounts of Flora and Fauna," Fish and Wildlife Service, Department of the Interior, Washington, D.C., 1982, 151 pp.

Anonymous, "Department of Agriculture Notes," Guam Recorder 14(5):21, 1937a.

Anonymous, "Department of Agriculture Notes," Guam Recorder 14(6):24, 1937b.

Anonymous, "Department of Agriculture Notes," Guam Recorder 14(12):11, 1938.

Anonymous, "Saipan's Sablan," New Yorker September 3, 1955, pp. 21-22, 1955a.

Anonymous, "untitled," U.S. Naval Administration Unit, 1955b.

Anonymous, "Will Release More Euglandina snails," Guam Daily News January 25, 1961, p. 3, 1961.

Anonymous, "Tilapia Farming on Guam" Guam Aquaculture 83-4:1-2, 1983.

Aquatic and Wildlife Resources Division, "Job Progress Report, Federal Aid to Fish and Wildlife Restoration Guam," Department of Agriculture, 1977.

Asami, R., "Brief Account of the Prolific Propagation of Snails in Asahi Village in Palau," Nanyo Keizai Kenkyujo 1943:1-5, 1943. (In Japanese)

Asano, N. "On the Distribution and Variation of Top Shells in Truk," Suisan Kenkyushi 32(5):255-259, 1937. (In Japanese)

Asano, N. "Takasegai Experiment with Transplantation," South Seas Fisheries News 2(4):16-23, 1938. (In Japanese)

Baker, R. H. "Some Effects of the War on the Wildlife of Micronesia," Transactions actions of the Eleventh North American Wildlife Conference, pp. 205-213, 1946.

Baker, R. H., "The Avifauna of Micronesia. Its Origin, Evolution, and Distribution," University of Kansas Publication Museum of Natural History 3(1):1-359, 1951.

Baldwin, W. J., "A Review of the Use of Live Baitfishes to Capture Skipjack Tuna, *Katsuwonus pelamus*, in the Tropical Pacific Ocean with Emphasis on Their Behavior, Survival, and Availablity," *NOAA Technical Report NMFS Circular* 408:1-35, 1977.

Barbeheen, K. R., "The House Shrew on Guam," *Pacific Island Rat Ecology*, Storer, J. I. (ed.), Bulletin B. P. Bishop Museum 225, 1962, pp. 247-256.

Barbeheen, K. R., "Recent Invasions of Micronesia by Small Mammals," *Micronesica* 10(1):41-50, 1974.

Beck, M. J.; Cardina, T. M.; and Alicata, J. E., "Eosinophilic Meningitis due to Angiostrongyliasis cantonesis in American Samoa," *Hawaii Medical Journal* 39(10):254-257, 1980.

Berry, R. J.; and Jackson, W. B., "House mice on Enewetak Atoll," *Journal of Mammalogy* 60(1):222-225, 1979.

Bright, G. R.; and June, J. A., "Freshwater Fishes of Palau, Caroline Island," *Micronesica* 17(1-2):107-111, 1981.

Brock, V. E., "The Introduction of Aquatic Animals into Hawaiian Water," *International Revue Gesammte Hydrobiologie* 45(4):463-480, 1960.

Brock, V. E.; and Yamaguchi, Y., "A Limnological Survey of Fena River Resevoir, Guam, Marianas Islands," Division of Fish and Game, Territory of Hawaii, 1955, 16 pp.

Brock, V. E.; and Takata, M., "A Limnological Resurvey of Fena River Resevoir, Guam, Marianas Islands," Division of Fish and Games, Territory of Hawaii, 1956, 9 pp.

Brown, H. L., "Log Field Trip--USS LSM 448-15 October 1955," Unpublished, 1955, 3 pp.

Brown, H. L., "Field Trip Report with Pertinent Information--3 March 1961," Unpublished, 1961, 6 pp.

Brown, W. C., "The Distribution of Terrestrial Reptiles in the Islands of the Pacific Basin," *Proceedings of the 8th Pacific Science Congress* 3A:1479-1491, 1956.

Chernin, M. I., "Population Dynamics and Reproductive Strategy of *Bufo marinus* (L.) on Guam," Master of Science Thesis, University of Guam, 1979, 56 p.

Christensen, C. C., "Are *Euglandina* and *Gonaxis* Effective Agents for Biological Control of the Grant African Snail in Hawaii?" *American Malacological* Bulletin 2:98-99, 1984.

Clarke, B.; Murray, J.; and Johnson, M. S., "The Extinction of Endemic Species by a Program of Biological Control," *Pacific Science* 38(2):97-104, 1984.

Colman, P. H., "An Introduction of *Achatina fulica* to Australia," *Malacological Reviews* 10:77-78, 1977.

Courtenay, W. R., Jr.; and Robins, C. R., "Exotic Aquatic Organisms in Florida with Emphasis on Fishes: A Review and Recommendations," Transactions of the American Fisheries Society 102(1):1-12, 1973.

Davis, C. J., "Report on the Davis Expedition to Aguiguan July-August 1954. Ecological Studies, Island of Aguiguan, Mariana Islands as related to the African Snail, *Achatina fulica* Bowdich, and Its Introduced Predator, *Gonaxis kibweziensis* (E. A. Smith)," Invertebrate Consultants Committee for the Pacific, Pacific Science Board, 1954, 24 pp.

DeLeon, F.; and Liming, O. N., "History and Nature of Tilapia," Guam Department of Agriculture, 1956, 4 pp.

DeVos, A., Manville, R. H.; and VanGelder, R. G., "Introduced Mammals and Their Influence on Native Biota," Zoologica 41:163-194, 1956.

Diamond, J. M., "Historic Extinctions: A Rosetta Stone for Understanding Prehistoric Extinctions," Quaternary Extinctions, Martin, P. S.; and Kelin, R. G. (eds.), Tucson: University of Arizona Press, 1984, pp. 824-862.

Downs, T., "Birds on Tinian in the Marianas," Transactions of the Kansas Academy of Science 49(1):87-106, 1946.

Eldredge, L. G., "Impact of a Volcanic Eruption on an Island Environment," Pacific Science Association Information Bulletin 34(3):26-29, 1982.

Eldredge, L. G., "Coral Reef Alien Species," Human Activities Causing Damage to Coral Reefs: Knowledge and Recommendations, Salvat, B. (ed.), UNESCO, in press.

Eldredge, L. G., "Aguijan Revisited," Unpublished manuscript, 11 pp.

Esaki, T.; and Takahashi, T., "Introduction of the African Snail, *Achatina fulica* Ferussac into Japan, esp. Micronesia, and subsequent developments," Kagako Nanyo 4(3):16-25, 1942. (In Japanese)

Easteal, S., "The History of Introduction of *Bufo marinus* (Amphibia: Anura); a Natural Experiment in Evolution," Biological Journal of the Linnaen Society 16:93-113, 1981.

Falanruw, M. C., "Savanna, Old Field Roadsides," Life on Guam, Department of Education, Guam, 1976, 71 pp.

Fisher, H. I., "Locality Records of Pacific Island Retiles and Amphibians," Copeia 1948(1):69, 1948.

Forshaw, J. M., "Parrots of the World," Garden City, N.Y., Doubleday and Co., 1973, 584 pp.

Gail, R.; and Devambez, L., "Selected Annotated Bibliography of Trochus," South Pacific Commission Technical Paper 111:1-17, 1958.

Hadfield, M. G., "Extinction in Hawaiin Achatinelline Snails," Unpublished Manuscript, 1984, 27 pp.

Hadfield, M. G.; and Mountain, B. S., "A Field Study of a Vanishing Species, *Achatinella mustelina* (Gastropoda, Pulmonata), in the Waianae Mountains of Oahu," *Pacific Science* 34(4):345-358, 1981.

Hadfield , M. G.; and Kay, E. A., "The Multiple Villainies of *Euglandina rosea* (or its Human Proponents)," *Hawaiian Shell News* 29(4):5-6, 1981.

Hartin, M. H., "Birds of Guam," *Elepaio* 22(5):34-38, 1961.

Heslinga, G. A.; Orak, O.; and Ngiramengior, M., "Coral Reef Sancturies for Trochus Shells," *Marine Fisheries Review* 46(4):73-80, 1984.

Holdgate, M. W.; and Wace, N. M., "The Influence of Man on the Floras and Faunas of Southern Islands," *Man's Impact on Environment*, Detwyler, T. R. (ed.), New York: McGraw-Hill Book Co., 1971, pp. 476-492.

Honegger, R. E., "Eine Krote Erobert die Welt," *Natur and Museum* 100(10):447-453, 1970.

Ikebe, K., "Records of the Introduction of Top Minnows into the South Sea Islands," *Nanyo Suisan Joho* 3(9):7-10, 1939. (In Japanese, translation)

International Union for the Conservation of Nature, "The IUCN Position Statement on Translocation of Living Organisms; Introductions, Re-introductions and Re-stocking," Final Draft, IUCN, 1984, 14 pp.

Jenkins, J. M., "The Native Forest Birds of Guam," *Ornithological Monographs* No. 31, 1983, 61 pp.

Johnson, D. H., "Rodents and other Micronesian Mammals Collected," *Pacific Island Rat Ecology*, Storer, J. I. (ed.), Bulletin B. P. Bishop Museum 225, 1962, pp. 21-38.

Kato, G., "Fish Transportation Between Palau and its Adjacent Areas," *Kagaku Nanyo* 3(2):117-122, 1940. (In Japanese)

King, J., "Anglo-Nubian Bucks for Pohnpei," *Islander* August 11, 1985, pp. 8-9, 1985.

Knox, G. A., "Problems of Introduced Mammals on Pacific Islands with Special Reference to the New Zealand Offshore Islands," Regional Symposium on Conservation of Nature--Reefs and Lagoons, South Pacific Commission, 1973, pp. 225-237.

Kohler, C. C., "A Suggested Protocol for Evaluating Proposed Exotic Fish Introductions," Distribution, Biology, and Management of Exotic Fishes, American Fisheries Society, Abstract, 1981.

Knowles, R. P., "The Poison Toad and the Canine," *Veterinary Medicine* 59(1):38-42, 1964.

Kondo, Y., "The Giant African Snail (*Achatina fulica*) in Palau, Pagan, and Guam," Invertebrate Consultants Committee for Micronesia, Pacific Science Board, 1950, 13 pp.

Kondo, Y., "Report on Carnivorous Snail Experiment on Aguiguan Island; Primary and Secondary *Achatina*-free anreas on Rota, and Gigantism Among *Achatina* on Guam," Invertebrates Consultants Committee for the Pacific, Pacific Science Board, 1952, 50 pp.

Kourany, M.; Myers, C. W.; and Schneider, C. R., "Panamanian Amphibians and Reptiles as Carriers of *Salmonella*," *American Journal of Tropical Medicine and Hygiene* 19(4):632-638, 1970.

Krumholz, L. A., "Reproduction in the Western Mosquitofish, *Gambusia affinis* (Baird & Girard), and its Use in Mosquito Control," *Ecological Monographs* 18:1-43, 1948.

Lachner, E. A.; Robins, C. R.; and Courtenay, W. R., "Exotic fishes and Other Aquatic Organisms Introduced into North Americaa," *Smithsonian Contribution in Zoology* 59:1-29, 1970.

Lai, P.; and Nakahara, L. M., "Evaluation of the Giant African Snail Control Program in American Samoa," Unpublished, Hawaii Department Agriculture, 1980, 12 pp.

Lai, P.; and Miyahira, N., "Re-evaluation of the Giant African Snail Control Program," Unpublished, Hawaii Department of Agriculture, 1981, 5 pp.

Lambert, J. F.; and Bryan, P. G., "Testing Topminnows (*Poecilia mexicana*) as Live Bait While Trolling for Tunas in American Samoa," *Pacific Tuan Development Foundation Technical Bulletin* 3:1-78, 1979.

Langford, D. B., "Entomological Investigations on Yap and Palau," Unpublished Insect Control Committee for Micronesia, Pacific Science Board, 1948.

Li, H. W.; and Moyle, P. B., "Ecological Analysis of Species Introduced into Aquatic Systems," *Transactions of the American Fisheries Society* 110(6): 772-782, 1981.

Lobel, P. S., "Invasion by the Mozambique Tilapia (*Sarotherodon mossambicus*; Pisces; Cichlidae) of a Pacific Atoll Marine Ecosystem," *Micronesica* 16(2):349-355, 1980.

Long, J. L., "Introduced Birds of the World," New York: Universe Book, 1981, 528 pp.

Lovshin, L. L., "Tilapia Hybridization," *The Biology and Culture of Tilapias*, Pullin, R. S. V., and Lowe-McConnell, R. H. (eds.), International Center for Living Aquatic Resources Management, Manila, pp. 279-308.

Maciolek, J. A., "Exotic Fishes in Hawaii and Other Islands of Oceania," *Distribution, Biology, and Management of Exotic Fisheses*, Courtenay, W. R., Jr.; and Stauffer, J. R., Jr. (eds.). Baltimore: Johns Hopkins University Press, 1984, pp. 131-161.

McGowan, J. A., "The Trochus Fishery of the Trust Territory of the Pacific Islands," Unpublished Report to the High Commissioner, 1958, 46 pp.

Marshall, J. T. Jr., "Norway Rat," Pacific Island Rat Ecology, Storer, J. I. (ed.) Bulletin B. P. Bishop Museum 225, 1962a, pp. 239-240.

Marshall, J. T., Jr., "House Mouse," Pacific Island Rat Ecology, Storer, J. I. (ed.), Bulletin B. P. Bishop Museum 225, 1962b, pp. 241-246.

Mead, A. R., "The Giant African Snail: A Problem in Economic Malacology," Chicago, University of Chicago, Press, 1961, 257 pp.

Mead, A. R., "A Flatworm Predator of the Giant African Snail Achatina fulica in Hawaii," Malacologia 1(2):305-311, 1963.

Mead, A. R., "Economic Malacology with Particular Reference to Achatina fulica," Pulmonates, Fretter, V.; and Peake J. (ed.). New York, Academic Press, 1979, 150 pp.

Muniappan, R., "Snail Falls Victim to Flatworm," The Sunday News January 25, 1981, p. 21, 1981.

Muse, C.; and Muse, S., "The Birds and Birdlore of Samoa," Walla Walla, Washington: Pioneer Press, 1982, 156 pp.

Nelson, S. G.; and Cushing, F. A., Jr., "Survey of a Brackish Lake on Pulusuk with Regard to its Potential for Fish Culture," University of Guam Marine Laboratory Technical Report 77, 1982, 19 pp.

Oda, D. K.; and Parrish, J. D., "Ecology of Commerical Snapper and Grouper Introduced to Hawaiian Reefs," Proceedings fo the Fourth International Coral Reef Symposium 1:59-67, 1982.

Owen, R. P., "Report on the First Carnivorous Snail Release on Aguiguan Island," Report to High Commissioner, Trust Territory of the Pacific Islands, 1950, 4 pp.

Owen, R. P., "A Checklist of the Birds of Micronesia," Micronesica 13(1):65-81, 1977a.

Owen, R, P., "Terrestrial Vertebrate Fauna of the Palau Islands," Unpublished Office of the Chief Conservationist, Trust Territory of the Pacific Islands, 1977b, 15 pp.

Parkinson, B. J., "Trochus Resources Survey," United Nations Industrial Development Organization (UNIDO), 1980, n.p.

Pemberton, C. E., "Local Investigation on the Introduced Tropical American Toad Bufo marinus," Hawaiian Planter's Record 38(3):186-192, 1934.

Perez, G. S. A., "Ecological Features of Philippine Turtle Doves on Guam, in Relation to Some Management Implications," Transactions of the IX International Congress of Game Biologists, 1970, pp. 832-838.

Pernetta, J. C., "Introduced Animals and Plants, Their History and Effects on Native Species," Traditional Conservation in Papua New Guinea: Implications for Today, Morauta, L.; Pernetta, J.; and Heaney, W. (ed.), Institute of Applied Social and Economic Research, Monograph 16, 1982, pp. 385-388.

Pernetta, J. C.; and Watling, D., "The Introduced and Native Terrestrial Vertebrates of Fiji," Pacific Science 32(2):223-244.

Peterson, G. D.; "Suncus murinus, a Recent Introduction to Guam," Journal of Mammalogy 37(2):278-279, 1956.

Peterson, G. D., "Studies on Control of the Giant African Snail on Guam," Hilgardia 26(16):643-658, 1957.

Pointer, J. P.; and Blanc, C., "Achatina fulica en Polynesie Francaise. Situation en 1982-83 en Polynesie Francaise apres l'introduction des escargots geants en 1967," Centre de l'Environment, Moorea, Rapport RA13, 1984, 42 pp.

Prowazek, S. von, "Die Deutschen Marianen Ihre Natur und Geschichte," Leipzig: Johan Ambrosius Barth, 1913, 125 pp.

Quoy, J. R. C.; and Gaimard, P. J., "Voyage of the Uranie and the Physicienne, Zoology," 1824, 712 pp.

Randall, J. E., "New Records of Fishes from the Hawaiian Islands," Pacific Science 34(3):211-232, 1980.

Randall, J. E.; and Kanayama, R. K., "Marine Organisms--Introductions of Serranid and Lutjanid Fishes from French Polynesia to the Hawaiian Islands," Costin, A. B.; and Groves, R. H. (ed.), Nature Conservation in the Pacific, Canberra: Australian National University Press, pp. 197-200.

Ripley, S. D., "Migrants and Introduced Species in the Palau Archipelago," Condor 53(6):299-300, 1951.

Safford, W. E., "The Useful Plants of the Island of Guam," Contributions from the United States National Herbarium 9:1-416, 1905.

Savage, J. M., "Geographic Variation in the Tadpole of the Toad, Bufo marinus," Copeia 1960(3):233-236, 1960.

Savidge, J. A., "The Role of Disease and Predation in the Decline of Guam's Avifauna," Doctor of Philosophy, University of Illinois at Urbana-Champaign, 1985.

Schnee, P., "Einiges uber die Hohere Tiewelt der Marianen," Zeitscrift fur Naturwissenschaften 82(6):458-470, 1912.

Shepard, J. W.; and Myers, R. F., "A Preliminary Checklist of the Fishes of Guam and the Southern Mariana Islands," University of Guam Marine Laboratory Technical Report 70:60-88.

a

a

Background Paper No. 3

CULTURAL DIMENSIONS OF RESOURCE DEFINITION AND USE IN MICRONESIA

by

William H. Alkire
Department of Anthropology
University of Victoria, British Columbia

1986

Prepared for

U.S. Congress, Office of Technology Assessment,
Integrated Renewable Resource Management for U.S. Insular Areas,
Washington D.C.: U.S. Government Printing Office, 1987.

CONTENTS

I. Introduction ....

II. The Micronesian Environment ....

1. Climate and Resources ....
2. Resource Zones ....
3. Environment and People ....

III. Cultural Systems and Ecosystems ....

1. Rank and Status ....
2. Genealogy, Male Bias and Primogeniture ....
3. Sibling Sets and Estates ....
4. Locality and Priority of Settlement ....
5. Expertise ....

IV. World View and Resources ....

1. Dualism in Polities and Exchange ....
2. Dualism in Exploitation ....

V. Principles in Action: High and Low Islands ....

VI. Modern Transformations ....

1. Resource Definitions ....
2. Authority ....
3. Resource Use: Collectives vs. Individuals ....

VII. Conclusions ....

Notes ....

Bibliography ....

CULTURAL DIMENSIONS OF RESOURCE DEFINITION AND USE IN MICRONESIA

William H. Alkire
University of Victoria

I. Introduction

In recent years the cultural diversity of Micronesia has been emphasized more frequently than any cultural similarities or regularities.[1] Such differences are undeniable and derive from differentiation that has occurred since initial settlement. In the two to three thousand years that many of this region's islands have been occupied ample time has passed to permit and promote such differentiation.[2] Nevertheless, it is also the case that a number of cultural similarities exist: a common Austronesian cultural heritage, similar ecological settings, and cultural diffusion all are involved in explaining such regularities.[3] Many of the particulars concerning resource definition and use on the individual islands of Micronesia derive from these commonalities. This article will attempt to identify some of the more important cultural dimensions and relate them to the process of adaptation and resource use.

Both "high" volcanic islands and "low" coral islands will be considered but the primary focus will be on the coral island societies that lie between Yap and Truk, where traditional subsistence practices have been retained to the present and where the forces of modernization have more recently been felt.

These societies, owing both to their isolation and their participation within indigenously developed socioeconomic exchange networks have maintained a higher degree of self-sufficiency than most other islands of the region. These societies therefore offer an opportunity to identify cultural categories that probably are basic to most of Micronesia, but which are difficult to delineate in other areas owing to the major economic and subsistence changes that have followed from mercantilism, plantation development and wage-labor dependency.

Two generalizations are underscored in this analysis:

> (1) In all cases, traditional adaptation was grounded in a system that guaranteed access to a wide range of resources. Therefore, adaptation was not limited to a single district or island, but included a wider multi-district and multi-island, reef, and sea ecosystem.
>
> (2) Culturally based systems of classification mediated resource definition and use. One must recognize this type of cultural data if one is to understand past resource use as well as the way future opportunities are likely to be viewed and interpreted.

II. The Micronesian Environment

Discussions and analyses of the Micronesian habitat have generally emphasized contrasts between "high" and "low" islands.[4] The larger, high, volcanic islands are usually described as richer and more productive habitats in contrast to low coral islands. The latter possess poorer soils, severely restricted land areas, low freshwater reserves, more limited inventories of plants and animals, and topographic features that provide little shelter for vegetation or habitations in the event of strong winds and high seas.[5] In many ways these are relatively accurate characterizations, but it must be kept in mind, on the one hand, that some of the volcanic islands have large tracts of land that are relatively unproductive (perhaps owing to past over exploitation or to some specific limiting characteristics of the natural environment), and on the other hand, nearly all of the "impoverished" coral islands support populations as dense as neighboring high islands.[6]

1. Climate and Resources: There are several points regarding the Micronesian environment that require emphasis:

(1) *Rainfall*: Exceptionally high average rainfall in the central Carolines (100 to 130 inches per annum) promotes lush growth of many types of vegetation. On coral islands such rainfall partially compensates for low freshwater storage potential in the porous and infertile soils. In the Marshall Islands, the other major coral island chain of Micronesia, only the southern islands have equally high rainfall. The volcanic islands of the region frequently experience even heavier rainfall, but those that lie north of eight to ten degrees latitude experience more seasonally distinct patterns. Yap and the Marianas, therefore, often have seasonal droughts that limit agricultural expansion and intensification.

(2) *Storms*: The western Carolines and the Marianas frequently experience tropical storms and typhoons. Important subsistence crops can be extensively damaged at such times and several years may be required for recovery to pre-storm levels of production.

(3) *Vegetation*: The inventory of subsistence crops includes species that are relatively well adapted to poor soils and saltwater contamination. On some islands these may be the most important staples. while on others they are emergency crops that are only turned to when others have been damaged by droughts or storms.

(4) *Marine resources*: A relatively rich marine environment in many areas significantly supplements land productivity. Of special importance here are reefs and uninhabited islets. In some cases islanders may have once voyaged considerable distances in order to exploit such areas.

2. Resource Zones: The typical volcanic and coral island possesses a number of relatively distinct environmental zones. High islands have generally been described as having three: (1) a coastal strand and foreplain where most villages are localized: (2) an inland area of low hills and sheltered valleys where major agricultural crops are concentrated: and (3) an interior of higher. often rugged mountains that is exploited for forest products.[7] A parallel three-fold classification of micro-zones exists on coral atoll islands: (1) the lagoon strand and shore where villages are found: (2) an interior zone. frequently topographically somewhat lower in comparison to surrounding areas. that is the most sheltered for agricultural pursuits: and (3) the ocean shore. generally somewhat elevated. but poor in soils where a number of forest products are found.

Inhabitants on both high and low islands recognized the differing resource potentials of such zones. On the high islands land was commonly divided and allocated so that most kin groups and every political unit had access to parcels in each zone. This generally resulted in the island being divided into pie-shaped swaths that reached from the shore to the mountains. On atoll islands comparable land parcels extended from lagoon shore through the interior to the ocean. Through time and a variety of circumstances, such parcels might be subdivided and become discontinuous and dispersed. Nevertheless, the tenure system assured a degree of self sufficiency for kin groups and districts because key resources from all environmental zones were available within the family and local polity. Where this was not possible, exchange networks were formed within which necessary commodities were redistributed.[8]

3. Environment and People: No truly *natural* habitat now exists in Micronesia. The undistrubed environment that Austronesian colonists found when they first settled the islands probably could not have supported sustained occupation. The early settlers brought with them, or soon imported, nearly all of the food crops that became their staples. These crops -- *Cyrtosperma*, *Colocasia*, breadfruit, arrowroot, and yams -- were plants that had been domesticated elsewhere and were retained in their crop inventory only because they could be adapted to the particular environmental constraints of Micronesia. Therefore the environmental character of today's

Micronesia is the consequence of between one and three thousand years of human activity. In some cases this activity has articulated well with the natural environment in that an ecological balance has developed. In other cases, agricultural activities and more modern mercantile, and plantation development as well as urbanization and incipient industrialism have resulted in varying degrees of environmental degradation.[9]

III. Cultural Systems and Ecosystems

1. Rank and Status: One Austronesian principle of organization strongly manifested in Micronesia is that of rank. In his analysis of Polynesian status ranking, Irving Goldman proposed that comparative status derived from the interaction of five variables: genealogy, priority of the male line, supernatural power (*mana*), military prowess (*toa*), and individual expertise *tohunga*).[10] It seems likely that in pre-European times in Micronesia all of these variables also played greater or lesser roles in determining individual status. Since that time, however, with the changed circumstances of the colonial era the relative importance of each has undoubtedly changed from traditional times. For example, pacification decreased the importance of military prowess (although some analysts have noted a continuing, often displaced, importance of war-like aggression in such areas as Truk, Ponape, Palau, and the Marianas).[11] Supernatural power, similarly, in most areas is no longer expressed in its traditional form, but has been replaced owing to conversion to

Christianity by rank within the church.[12] The three remaining principles -- genealogy, priority of the male line, and expertise -- continue in importance, perhaps with somewhat less modification. In addition emphasis is also placed on primogeniture, siblingship, locality and estate membership as principles.

2. Genealogy, Male Bias, and Primogeniture: In most of Micronesia named matrilineal clans are the principal genealogical units.[13] In the central Carolines they are called *gailang* and these can serve as a model for this discussion. On any one island the local membership of a particular clan frequently is putatively descended from a common founding ancestress and therefore shares many inheritance and succession rights. On most islands this branch of a clan is not differentially named and it is possible for more than one of these *subclans* to be found on an island. Functionally, however, the most important descent group is the *lineage* (a branch of the subclan). It is tied to or identified with a particular named piece of land, an *estate*.

It is important to realize that the estate and its members are inseparably linked. For example in the central Caroline atolls the term *bwogot* is used interchangeably to refer to the land (estate) or the people of the land (the "family"). One might identify himself as a member of *Falagol bwogot* using the estate name. He might also identify himself through linkage to the current head of the estate, e.g., "I am a member of Igomai's *bwogot*." This could be glossed as "Igomai's family."

Here the principles of male priority and *primogeniture* are highlighted. Igomai, as the senior male, is the head of his matrilineage. But Igomai, is married and in this matrilocal society he therefore does not continuously live at *Falagol* estate. His residence is with his wife on her estate lands.

Four important understandings follow from this example:

> (1) Lineage membership is dispersed. Adult males live elsewhere (with their wives) while adult females and their children reside on estate lands.
>
> (2) All members of the estate group share rights in the resources of the estate, whether in residence or not (those in residence, of course, more frequently exploit those resources).
>
> (3) The male head, who lives "away", is obliged to visit the estate frequently since he has stewardship responsibilities there.
>
> (4) The 'old woman' of the estate, following the principle of primogeniture, is usually the sister of the lineage head. She *is* continually in residence and exercises equal internal authority over estate membership and exploitation of its resources. This unit, the male head and his sister is perhaps, *the* fundamental kinship unit in Carolinian and most Micronesian society, technically it is termed a *cross-sibling set.*[14]

3. Sibling Sets and Estates: Micronesian folklore is replete with references to the importance of brother-sister pairs.[15] In matrilineal Micronesia women are the founders of clans, subclans, and lineages, while their brothers are the public spokesmen, representatives, and guardians of the "family," with responsibility for the welfare of their sisters and their sister's children.

In some parts of Micronesia the male bias principle has become more strongly expressed and the rule of residence is now *patrilocal* even though descent is matrilineal. In such cases genealogy is less closely linked to estate membership than is the rule of residence. Yap is one such example.[16]

Let me emphasize several important points that follow from the above discussion as they might relate directly to resource rights and use:

> (1) Land rights of a Carolinian matrilineage are dispersed and include a number of land parcels, reef and fishing areas on a single island and quite likely on other islands as well.
>
> (2) All members of a lineage share "ownership" rights and these are exercised publically through the lineage head, the senior male who resides away from the holdings, and less publically by his sister, who resides on the estate.
>
> (3) Many members, with such rights, reside (as does the above mentioned head) elsewhere; some may live on distant islands where they have married or been adopted.
>
> (4) It therefore follows that decisions regarding lineage land holdings and resources are not lightly or easily made. A lineage head is truly a steward of its holdings; he cannot arbitrarily or autocratically make decisions about converting lands to new uses or dispose of holdings -- certainly not without consulting his sister and usually not without consulting the majority of lineage members who ultimately are dependent on those holdings for their current and future sustenance and survival. Such consultation is frequently a slow process when senior lineage members reside on distant islands.

The *ecosystem* of an individual lineage is therefore complex and dispersed. As lineage members gain new rights (via adoption, marriage, gifts, or residence) all or a part of such rights become common lineage rights. The system has the advantage of maximizing survival by increasing and dispersing the subsistence base of the key social units of the society, but it has the disadvantage of frequently resulting in a multiplicity of conflicting priorities, claims and counter claims to such resources. When these come into conflict disputants usually invoke more restrictive interpretations of descent in order to bolster claims. Kinship, descent, and residence, then, are continuously interacting. Herein lies a basic reason for the frequency of land disputes in Micronesian societies.

4. Locality and Priority of Settlement: The importance of seniority and primogeniture can also be seen in the context of political organization. In this case I have labelled its expression the *principle of priority of settlement*.[17]

The discussion thus far has emphasized the importance of hierarchical ranking in Micronesia. The mythic charters (folklore) that justify the existing social order frequently make reference to founding cross sibling sets that originally settled and *laid claim* to particular islands. These brother-sister pairs established the primacy of their clan on the island while their spouses, accompanying voyagers, or later settlers gave rise to other clans. These earliest settlers claimed ownership of all land and reef areas present. Consequently, no unowned or pioneer areas existed on an island from the time of first settlement. If more than one clan putatively settled the island at the same time (as would have beem the case when a sibling set was accompanied by spouses), then the island might be divided equally between the two or three clans represented.[18] Regardless of the "historical accuracy" of such myths the rule delineated emphasizes that those individuals who first arrived had prior claims to an island and its resources, those who arrived later received their rights from those already present and therefore occupied a lower rank within the society.

Nearly all of the coral islands of the central and western Carolines are divided into two or three districts. Each district has a chief who represents the founding clan of that district or the clan that now possesses the largest land holdings within the district. All other clans that reside within the district are lower ranking "later arrivals" who, on ceremonial occasions, present "first fruits" to the district chief in recognition that their rights to the resources of the district derive from the founders. Recognition of these "original" rights assures the lower ranking lineages of continued "exploitation" rights. A number of district, island, and interisland ceremonies and rituals -- like the first fruits ritual, just mentioned -- emphasize a similar interdependence of social groups and geographic areas.

The widest traditional manifestation of such, were a number of interisland socioeconomic exchange systems. Among these, for example, were the *sawei* 'overseas', *hu* 'fishhook', and *chulifeimag* 'intra-atoll' exchange systems that involved, respectively, nearly all of the islands between Yap and Truk, the islands of "greater" Lamotrek, and the islands of Woleai atoll.[19] In other areas (e.g., the Marshalls, Kosrae, and Ponape) sociopolitical linkages also united districts and islands of varying size and productivity.[20]

5. Expertise: In all such cases interisland voyaging was frequent and extensive. Here the principle of *expertise* as a status determinant is highlighted. Genealogical rank could be supplemented, complemented and compensated for, by undertaking specialized training in a number of domains. Foremost among experts were navigators. Maintaining communication with dispersed kinsmen and exploitation of dispersed holdings depended upon reliable interisland travel. In turn, frequent interisland travel increased the probability of interisland marriages, adoptions, land transfer, descent (clan) ties, multi-lingual competences, diffused innovations, and shared expectations. Hospitality and aid for the inter-island voyager, within the outer islands, was regulated both by kinship and an incipient political system, the *sawei*. Within this latter system, although local affairs remained under the juristiction of individual island chiefs, inter-island communication and exchange were regulated according to the hierarchical rank of each outer island and the pre-eminent standing of Gagil on Yap. Participation in the system involved rights and obligations for all parties; perceived rights in land and resources were fundamental to it; and, in a sense, all depended on the navigator.[21]

Expertise was emphasized in other domains as well. Specialists in canoe building, housebuilding, weather control, magic, divination, medicine, and agriculture were accorded prestige and rank. As will be discussed later the modern importance of a general education and technical training can be interpreted as deriving from these traditional roots. It is also significant, that specializations were ranked and defined according to contrasts and linkages between the domains of land and sea.

IV. World View and Resources

Resource definition and use are significantly influenced by *world view*. Here is meant the culturally defined and accepted "natural order." Micronesians do not differ from other societies in believing that rules for such order exist, only in the specifics of those rules. Kinship, social and political organization are part of this order, and the principles of organization that operate in those spheres are frequently transformations of principles that govern larger spheres of relationships -- not only relationships between groups and classes of people, but also between people, nature, and the supernatural.

1. Dualism in Polities and Exchange: The Micronesian world view, like that of many Austronesians, emphasizes dualistic oppositions, quadripartite divisions and mid-points as loci of control and mediation.[22] I have discussed these principles in a number of publications and will limit the current comments to those areas that have direct relevance to resource definition and use.

It has been pointed out that the polities of the central Carolines were divided into two or three units. Folktales provide locally acceptable explanations for this. Nevertheless, one should not ignore the functional and adaptive dimensions of such an order. Efficient resource use and survival depended on extensive networks of exploitation and exchange. Exchange and labor perhaps could be based on individual negotiations and contractual arrangements, but such would be time consuming, variable, inefficient, and probably mutually subject to frequent misinterpretation and conflict. Instead, in most cases collective or group arrangements prevailed. Exchange, by definition, requires a minimum of two parties and, if it is to be conflict free, reciprocity. In much of Micronesia and certainly in the central and western Carolines attempts were made to define exchange as involving two *and only two* parties. This frequently required the culture to redefine or categorize a multiplicity of participants in some dualistic fashion. On Yap the division between 'side of the young men' and 'side of the chiefs' was one; on Palau 'sides' and 'others' in clans, clubhouses, villages and 'heavens' were dualistic divisions; in Ponape reciprocal rights and obligations existed between senior and junior lines of titles; in the Marshalls senior and junior lines and dualistically competing polities developed; and in the central Caroline atolls dualistically balanced districts and lagoons were common.[23] In nearly every case, as well, male vs. female and land vs. sea were fundamental divisions central to exchange. Exchange that is so conceived minimizes imbalances, regularizes communication and presumably minimizes conflict by maximizing unity.

Of course, it is not always possible to easily divide parties dualistically in any obviously logical fashion. When that was the case the principle was not abandoned in favor of some other, but rather invoked in a further transformation. That is, a perceived dualistic division was again dualisitically subdivided, a process Eyde has named *recursive dualism*.[24] As a consequence of this process we frequently encounter quadripartite units in Micronesia.

No social system is perfect, however, and although the process may regularize exchange in an acceptable way on most occasions, as the parties increase in size and their interests diverge the potential for conflict increases; hence the need for a mediator or adjudicator. On the larger and more densely settled islands one finds, for example, north, middle and south districts or east, middle, and west districts. Here the middle district, in one or another way, mediates between the other two. One can conceive of lineage stewards or chiefs operating in a similar way, mediating between laborers and consumers, land owners and land users, and between high ranking and low ranking residents. Chiefs rarely had autocratic rights in the central Carolines; they suggested customary solutions to recurring problems among disputing parties. In some of the more densely settled and hierarchically ranked areas -- primarily on the high islands of Yap, Ponape, Kosrae, and Palau -- chiefs began to transcend the role of mediator and steward to become more powerful political forces representing territorial units rather than kin groups.

2. Dualism in Exploitation: In most of Micronesia male and female domains are quite distinct. Matrilineality ties land inheritance directly to females. Symbolic associations that are follow from this are: interior land and its products are primarily the concern of females; women are the prime horticulturalists cultivating *Cyrtosperma* and *Colocasia*; and dwellings (where lineages are centered) are female areas. Conversely, the sea and areas of land bordering the sea are male areas; canoe houses are male areas; canoes and overseas travel are the special concern of men; fishing is primarily a male activity and coconuts (and certain other tree crops), which project from the land and border the sea are male products.[25] Male and female domains, activities, and products are therefore complementary. Daily subsistence activities, as well as the ceremonial ritual activities already mentioned, serve to symbolically emphasize the interdependence and interrelationship of kin groups, the sexes, people of high and low status, land and sea, districts, islands, and island clusters. What results is an ecosystem of land, sea, reefs, and their resources inextricably interwoven with people, clans, lineages, ancestors and the wider supernatural world.

V. Principles in Action: High and Low Islands

Traditional subsistence in Micronesia, whether on high or low island, was based on a combination of root and tree horticulture and marine exploitation. The larger, more protected land areas of high islands allowed cultivation of a larger inventory of plants, greater reliability in productivity and larger and more stratified polities. Ranking, dualism, center and periphery, and reciprocity were important principles of societal order. For example, on Palau two large political alliances formed around four primary centers that in turn were linked to outlying peripheral districts and villages.[26] In Ponape major and minor chiefly lines of titles governed dualistically divided districts and subdistricts.[27] On Yap two major political alliances, one of the north and one of the south, vied for control while a third "middle" alliance held a balance of power and periodically shifted between the two.[28] Only Truk, among Micronesia's high islands, failed to consolidate into a number of supra-local and/or interisland polities. At Truk individual islands and districts continued in competitive warfare rather than integrated exchange.[29]

Within such polities exploitation patterns were shaped by a number of considerations and among these kinship and residence have already been discussed. Male/female and land/sea contrasts were also important. On both high and low islands the most common sexual division of labor saw women as the primary horticulturalists and men as fishermen. Therefore, by extension or analogy, land and the interior areas of an island were identified with females while the sea and exterior areas of the island were male. Following from the principle of male bias, male areas were ranked superior to female areas. Men's houses and canoe houses were located along the shore or coastal fringe, while female-centered dwellings were inland.

On the larger high islands the male/female associations of these areas might be less frequently emphasized, but the superior/inferior aspects retained. Thus on Yap, a highly stratified society, coastal villages were high ranking while interior villages were low (frequently being settled by members of the landless caste). It was also the case in Kosrae and Ponape that the highest ranking centers of traditional times (Lelu and Nan Matol) were compounds constructed offshore from the main islands. Resources from "exterior/external" areas, therefore were frequently ranked higher than those from "interior/internal" areas. These conceptualizations, as will be discussed later, have some relevance to modern Micronesian attitudes toward imported goods and resources. In traditional times status and rank could be improved by forging external alliances. The relations between Gagil on Yap and the outer islands of the central Carolines or Yap and Palau are illustrative of this.

Archaeological evidence notes the presence of high island products on the outer islands and vice versa while folklore and historical evidence emphasize both the frequency and wide range of voyaging among islands.[30] Not only were the central Carolinians linked to Gagil in a formal exchange system (the *sawei*), but central Carolinians also travelled to Palau, the Marianas, and Truk on a regular basis. The outer islanders through necessity and interest did not isolate themselves but sought out contacts with neighboring areas. The high islanders welcomed such contact and exchange for the same reasons and because such exchange increased status within their own polities.[31] In most cases, the outer islanders were the more active participants in the exchanges. The greater reliability of high island resources, larger land areas, and larger populations, as well as the greater importance of the high island resources to the outer islanders, help to explain why they accepted a lower social rank in such exchange.

For the low islanders the high islands provided ceramics, stones, bamboo, pigments, a variety of foods, and refuge in times of emergency. For the high islanders the low islands were sources for unusual and valued sea shells, hand crafted products (twines, mats, baskets and belts), laborers, and navigational and communication links that enabled reliable travel beyond the limits of their own archipelagoes. It should be emphasized, then, that the specialized knowledge and technical expertise of the outer islanders was soon recognized to be of great value by high islanders. And the outer islanders undoubtedly parlayed this "possession" to their advantage in dealing with the high islanders. We find, for example, that outer islanders were sought to ferry Yapese between Yap and Palau and similarly, at a somewhat later date, the Spanish colonists on Guam used Carolinians for transportation to the more northerly of the Marianas.[32]

In summary, in several areas of Micronesia high and low islands were linked through exchange systems of varying complexity. Such systems expanded the ecosystem of all participants and thereby resulted in a more stable subsistence base for low islanders and wider political influence for high islanders. The systems were closely articulated to fundamental cultural rules of order; in fact, such accepted aspects of order as hierarchical ranking, and land/sea, male/female, interior/exterior dualities provided a cosmic model that could easily expand in predictable ways.

In many ways the arrival of the Europeans in the Carolines in the late 18th and early 19th centuries did not diminish the interaction or interdependence of high and low islanders, but in some ways augmented and transformed it.

VI. Modern Transformations

1. Resource Definitions: When compared to most other areas of the Pacific, the Caroline coral islands were discovered rather late in the era of European exploration and mercantilism.[33] In many cases, given traditional voyaging patterns, the outer islanders "discovered" the Europeans before the latter knew of them, in that outer islanders were introduced to European trade goods in the course of their visits to the high islands. Metal, glass, ceramics, cloth, and tobacco were as valued on the outer islands as on the volcanic ones. Trade for foreign goods provided an additional reason for maintaining, increasing, and extending visits to those islands that Europeans frequented. Where voyaging was extended to areas infrequently visited in pre-European times, the outer islanders found it necessary to deal in resources their hosts valued in order to obtain European manufactured items. This occasionally led to a redefinition of exploitable resources.

The two primary commodities early European traders were interested in were copra and trepang. It was not possible to transport large quantities of these items to the high islands on the relatively small Micronesian canoes. Therefore outer islanders' trade for European goods was mediated through the people of the high islands.

As soon as the Europeans began to voyage directly to the outer islands (as they did with some frequency from the 1840s on) the situation dramatically changed. The amount of goods available increased significantly, the dependence of outer islanders on the goodwill of the high islanders decreased, and the orientation of outer islands economic activity began to shift from one based exclusively on subsistence production and manufacture (or collection) of items for high island consumption, to include cultivation and production of coconuts and trepang valued by Europeans.

An extremely important point to keep in mind regarding the cultural impact on outer islands' societies of this altered economic reality was that these were products already familiar to the outer islanders. Coconuts were a traditionally defined resource with clearly understood rules of use and ownership. Trepang were distributed naturally within most lagoons, but in most instances were not defined as a *resource*, since little traditional use was made of them. However, tenure rules that applied to the reef and lagoon were extended to include the organism. Thus the move to a more mercantile and monetized economy initially only required intensification and extension of rules already in place.

Areas of an island that previously had not been intensively cultivated with coconuts, for example, were put into production. Since all areas of an island were "owned" no new land disputes were likely to result. Reef and lagoon areas were similarly "owned" by villages, lineages, subclans, or clans, and therefore exploitation of trepang merely required an extension of a pattern already in existence for shellfish.

Neither did the new patterns of exploitation require significant alterations in the sexual division of labor. Men were the traditional interisland voyagers and traders. The products in demand for European trade -- coconuts and trepang -- were *male*. Women, as a consequence, were left free to continue, with little disruption, cultivation and processing of *Cyrtosperma*, *Colocasia*, and breadfruit, the major subsistence crops. More serious cultural disruption occurred in those areas (e.g., the Marshalls) where the copra trade led to plantation development and consequently alterations in traditional patterns of tenure and labor.

European trade had a number of similar effects on high islands. Old centers, if they were able to monopolize trade retained their preeminent position. Koror in Palau is a good example.[34] On those islands where trade, for one or another reason, bypassed traditional centers new nodes of power arose. Colonia on Yap is such an example and there power shifted from Gagil to Rull. Outer islanders who visited high islands were interested in the trading centers and therefore new alliances between them and the high islanders frequently emerged. Once colonial control was firmly established in the Carolines (during the German period of administration) the frequency of outer islands' voyagers visiting the high islands decreased because administration ships now took trade directly to the outer islands. The particular policies and interests of each colonial authority from that time to the present has influenced relations between high and low islanders. The central Caroline atolls can, once again, be used as an example.

Shortly after the the U.S. Navy assumed administrative control of Micronesia at the end of World War II the pattern of servicing and trading with the outer islands was changed. From the earliest colonial times through the Japanese era contact with the outer islands had always been through Yap. For a two year period the U.S. Navy shifted the administrative center responsible for the outer islands from Yap to Palau. Most outer islanders did not consider this retrogressive, but the Yapese did. The outer islanders believed that Palau offered new opportunities since there they were not defined according to the rigid traditional class structure of Yap and the *sawei*. The Yapese objected because they viewed loss of of the outer islands primarily as a loss of *land and resources*. These objections led the Navy to reestablish Colonia as a district center. In the late 1950s a number of the easternmost outer islands proposed secession from Yap and unification with Truk. Their objective was to link with a district where the traditional interaction was less bound by restrictions and hierarchical ranking. They believed that at Truk they would have freer access to western goods, jobs, and possibly land -- a resource denied them on Yap. Secession, however, was not permitted because of Yapese and Ulithian objections. More recently, attempts have been made to establish Ulithi as a district or state administrative sub-center. If government, education, health, and trading facilities were provided on Ulithi, outer islanders would not need to travel to Yap would as frequently. An important objective of those who favor this policy has been to establish Ulithi as a port of entry to the state. If this were the case, Ulithi could deal directly with Guam, eliminating any need to obtain commercial goods through Yap.

These secessionist and fragmentationist political moves within the state of Yap are parallel to those that have affected the whole of Micronesia (most recently in the Faichuk case). Traditional multi-island alliances were advantageous when they resulted in the distribution and redistribution of necessary and desired goods. But old alliances have broken down and new ones emerged as changing trading patterns offer new opportunities.

2. Authority: As the earlier discussions emphasized, authority in the outer islands is anchored in land and kinship. Land and people are the two most important resources of the region. Rank is fundamental in governing interpersonal relations and here the full inventory of status principles are taken into account: clan and lineage membership, sex, seniority, and expertise. Authority that derived from these variables legitimized decision making. Chiefs could impose taboos that controlled resource use thereby, to a degree, conserving such resources. Increased contact with and control by colonial authorities altered interaction, exploitation, and expectations.

Initially interaction and exchange with foreigners was modeled on the existing hierarchical framework. This hierarchy began to alter as the location and number of trading opportunities increased and as the definition of expertise changed. For example, as European contact with outer islands increased, the need to voyage to high island centers decreased. Direct trade with Europeans rather than with high islanders required developing new understandings since the Europeans were ignorant of the traditional rules that had regularized interaction between high and low islanders. Micronesians turned to mediators or *cultural brokers* for this purpose. These brokers were frequently individuals who were already mediators within Micronesian society. In the outer islands of the central Carolines they were often "middle district" chiefs.

Success in dealing with Europeans inevitably required mastering new skills. If trade with Europeans demanded expertise in their language, their religion, and their bureaucratic methods, then many Micronesians were eager to undertake study of such systems. After all, status had long required study and training in specialized domains. Inevitably this resulted in varying degrees of cultural conflict as "new" knowledge began to compete with "old." The crucial conflict was that which arose between authority based on kinship, seniority and the land base, and the authority that derived from expertise in the "new." In those instances where individuals who sought or were given opportunities for technical or linguistic training, were traditionally of high rank, the conflict was minimized. In those cases where ability in mastering such expertise did not coincide with genealogy, sex or age, the chances for a cultural "redistribution" of power increased. Since the school systems quite understandably began to promote the interests of those with ability rather than those of traditional rank, strains on the traditional system began to be felt both within the school systems and within the cultures at large.

Formal schooling also raised questions of competitiveness. In most cases cultural expectations prevented overt expressions of individual superiority if these conflicted with traditional rank. Even those of high rank who were schooled in "European expertise" found themselves frequently frustrated upon return home. Although expertise was a measure of rank, it was not the *only* measure and the age of the average student meant that even with their new knowledge, they were frequently overlooked in favor of traditionally more acceptable senior decision makers. Young men might be consulted for their expertise, but their seniors continued to make the final decisions. Many youths who thought education and acquisition of knowledge would guarantee a shortcut to power were frustrated in their ambition and became the focus for social tension. They no longer were willing to "wait their turn." Communities began to see increasing internal friction based on generation gaps, on land versus knowledge conflicts, and on tradition versus modernity. For this and the reason that their new gained knowledge might in fact have very little relevance to survival in hinterland communities such youths began to migrate to the port towns where their training qualified them for jobs. The urbanization of Micronesia was underway.[35]

3. Resource Use -- Collectives vs. Individuals: Traditional rights in and use of resources in Micronesia were based on membership in kinship and territorial groups. Colonial administrators, over the years, frequently complained that this "group orientation" inhibited development and entrepreneurship. Officials therefore attempted to promote a more individual orientation through alterations in rules of land tenure. Port town development and migration had a similar effect. The majority of migrants, as in the previously described case, were youths who found village life confining or irrelevant to their newly gained educations. Migration to port towns cut them off from their kin/land base and survival depended more on individual performance and labor.

At the same time a number of government services that previously had been centralized in the administrative centers were extended to outlying villages and islands. Among these were schools, dispensaries, and shipping. The personnel employed were newly educated local residents whose salaries and wages were paid from the district centers. This inflowing external money provided a new resource that began to alter the domestic economy.

Money had long entered hinterland communities through trade for copra, trepang, and trochus. Production of these commodities, as previously mentioned, had largely been based on traditional rules of tenure, therefore the money introduced into local communities had been redistributed via traditional collective channels. One manifestation of this was the cooperative store, which also had been promoted by colonial authorities as a mechanism to speed-up trade in outlying areas. These stores, however, periodically failed and apparently for two reasons. Firstly, in most cases the founding capital was derived from equal contributions from all families, estates, or lineages of a village. The storekeeper was generally selected from among the youths who had received some western education and therefore had some bookkeeping competence. Such youths, however, lacked the authority of seniority, and found it difficult to refuse credit to those who had contributed to the founding. The stores that appeared to survive were those where a senior man was installed as storekeeper and "steward." Secondly, the salaried government employees (teachers, health and transportation workers) began to use their earnings to open private stores in direct competition with the co-ops. These stores were responsible to smaller kin groups. With fewer individuals having a call upon their resources and with the ability to mark-up profits in sales to non-kin, their solvency was more assured, even though their practices generated significant community tensions. These "salaried store founders" had returned from off-island with western educations that emphasized a more "individualistic" orientation. Therefore they no longer willingly redistributed their wages or store profits widely throughout their kin groups.

Entrepreneurship in many areas of Micronesia has followed a similar pattern. Government employees and officials at many levels have used their salaries, or access to government loans, to found businesses. The pattern underscores the fact that government money is one of the few sources of capital and that rank can be used in a number of ways to improve individual and group position within the society. In some cases, especially in the more highly stratified societies, the profits derived from individual entrepreneurship are "reinvested" in ways meant to improve status in the traditional hierarchy. For example in Ponape wealthy entrepreneurs contribute lavishly to traditional feasts hoping to receive a high ranking title from a chief and the increased power and prestige this entails.[36]

VII. Conclusions

The cultural fabric of most of Micronesia and certainly of the more traditional areas of Yap and its outer islands is characterized by a ranked society. Rank is based on membership in kin groups and rights in land or estates. Decision making authority within such groups increases according to seniority, sex, and personal expertise or knowledge. Rivalries between competing groups on an island or within districts and villages are managed and kept in check through reference to a dualistic model of society and the world; a dualistic model that emphasizes complementary interests (e.g., north/south or east/west and land/sea or male/female). In those cases where the balance is in jeopardy (as often happens when there is competition for resources) mediation or adjudication is sought from a "mid-point."

The colonial history of the region has been long and complex. Spanish, German, Japanese, and American policies and programs have impinged upon and altered the traditional fabric in a myriad of ways, and yet aspects or transformations of these principles remain important. Those areas that have been most altered are those where the traditional power base has been destroyed or replaced; where traditional land tenure grounded in kin groups has been replaced by individuation and introduced systems.[37] The changes that have occurred in most islands, however, have been less drastic. In most cases introduced traits have been adapted to at least some persisting traditional patterns.

A number of regularities directly related to resource use and definition can be summarized as follows:

> (1) Introduced crops are categorized according to pre-existing patterns (i.e., interior/exterior or strand, interior, mountain).
>
> (2) Those crops and zones exploited most successfully are those that have not required alteration of traditional patterns of tenure or division of labor (i.e., copra, trepang, trochus).
>
> (3) The opposition of interior/exterior, land/sea, female/male and the traditional superiority of the second element in each of these dyads is manifested in a preference for external (overseas) goods over internal (domestic) ones, male entreprenuers over female ones and therefore an emphasis on storekeepers dealing in imported items rather than cultivators (or even fishermen) dealing in domestic production for export.

Traditional percepts are basic to understanding recent patterns related to monetization and migration. Most wage labor is not available in hinterland and outer islands communities, but only in the port towns. A degree of urbanization has followed and for hinterland areas the corallary to urbanization is hinterland depopulation. Copra production consequently became more difficult and in many areas decreased. The recent monetization of Micronesia, therefore, was based on external appropriations that were not linked to productivity. This kind of money interfaced with traditional cultural principles in only one way -- with the principle of expertise. Those who could expect employment and the increased status that derived from it, were those who mastered new knowldege. The education industry boomed.[38] New education, like new money, had little relevance to subsistence or survival on the islands of Micronesia. It was used largely to purchase imported foods and prestige goods. A divided Micronesia resulted, one where "newly educated" youths moved to the growing urban centers and "traditionally" oriented older people remained in outlying areas. This further undermined the subsistence economic system since the missing youths were major participants in domestic production.

There were political repercusions as well. The authority of traditional leaders began to erode as either their land or their kin based pool of manpower was significantly reduced. Competing political structures emerged in the urban centers based on western elected models and oriented toward the needs of the port towns. Chaos did not follow, however, because many of these changes were channelled and interpreted according to percepts of a traditional world view.

The dualistic orientation of tradition made it possible to accomodate a modern power structure of traditional chiefs and modern elected representatives. The elected leaders rarely proceeded without consulting traditional leaders and the latter frequently used the youthful elected leaders as intermediaries or "brokers" in dealings with colonial administrators. The dualistic system that evolved was one where the "old" leaders were willing to legitimate the "new" in return for the patronage the new were able to obtain from colonial authorities.[39]

Two possible courses of future development seem probable. The first would be based on increasing dependency and external support while the second would see a degree of self-sufficiency derived from recapturing some form of internal interdependence. It is unlikely that all Micronesians will choose a single option. Those areas that opt for the first alternative will undoubtedly see increasing rural to urban drift, increasing need for urban housing and infrastructure development, an increasing demand for wage labor, and increasing off-island migration to larger centers such as Guam, Hawaii and the United States. Those areas that opt for the second alternative will confront increasing need for infrastructural developments that will facilitate exchange and interdependence, i.e., road, ship and air transportation facilities and the development of domestic marketing and production.

Undoubtedly there are advantages and disadvantages in both courses. But it seems inevitable that deeply entrenched cultural patterns and principles will influence in the future, as they have in the past, the choices made and the new patterns that emerge.

NOTES

1. In this paper *Micronesia* will be used to refer to the current Trust Territory of the Pacific Islands. The emphasis on differences, in fact, has led to the fragmentation of the Trust Territory and the emergence of four political entities that will replace it, i.e., The Commonwealth of the Northern Mariana Islands, The Federated States of Micronesia, The Republic of the Marshall Islands, and the Republic of Belau. See, for example, Heine 1974:110-117; Mason 1974.

2. Archaeological evidence regarding the length of time many of the islands of Micronesia have been settled can be found in Spoehr 1957:66; Osborne 1966:464; Reinmann 1977:158-161; Gifford and Gifford 1959; Craib 1983; Fujimura and Alkire 1984:120-123; and Shutler, Sinoto, and Takayama 1984:58.

3. The common Austronesian heritage has been demonstrated linguistically, archaeologically and ethnologically. See Craib 1983; Shutler and Marck 1975; Grace 1961; Dyen 1965; and Alkire 1972.

4. Thomas 1968:13-18; Murphy 1949; Fosberg 1963; Alkire 1960.

5. See, for example, Alkire 1965 and 1978.

6. These and the issues of the next section have been discussed by Barrau 1961 and 1965; Alkire 1968a, 1974a, 1974b, 1978:32; Bayliss-Smith 1974; Hunter-Anderson 1984 and 1985; Bryan 1971; and Wiens 1962.

7. Thomas 1968; Barrau 1965; Alkire 1978:3-18.

8. Such exchange systems are discussed at length in Alkire 1965, 1978; and Lessa 1950.

9. The process of environmental degradation is not limited to modern times in the Pacific; see Kirch 1984:123-151 for a discussion of the archaeological evidence for such in Polynesia, a process that undoubtedly has parallels in other areas of Oceania. See also Barrau 1961:18.

10. Goldman 1970:9-16.

11. Aggression is discussed by Marshall 1979 for Truk; Riesenberg 1968 for Ponape; McKnight 1960 for Palau; and Spoehr 1954 for the Marianas.

12. In all of Micronesia, Kosrae (Kusaie) best exemplifies this; see Wilson 1968 and Ritter 1978.

13. The social organization of the central Carolines is discussed at length in Alkire 1965, 1970 and summarized in Alkire 1977.

14. See Marshall 1981 and 1984 for an extended discussion of siblingship in Oceania and Micronesia.

15. This issue is referred to in Alkire 1984a.

16. The complexities of Yapese social organization are discussed in Lingenfelter 1975; Labby 1976; and Schneider 1962 and 1984. This last reference deals directly with the issue of estates and genealogy. In many Micronesian cases individuals can affiliate with an estate in ways other than birth, e.g., adoption, prolonged residence through marriage, formalized friendship, and patrilateral affiliation.

17. This issue is discussed in Alkire 1984a, 1984b.

18. One example from folklore is found in Lessa 1961:35; a number of others are referred to in Alkire 1984a.

19. See Alkire 1965 and 1970; Lessa 1950.

20. See Spoehr 1949 and Tobin 1953 for the Marshalls; Wilson 1968 and Ritter 1978 for Kosrae; and Riesenberg 1968 for Ponape.

21. Micronesian methods of navigation have been discussed in a large number of publications. Among them are Davenport 1960; Alkire 1970; Gladwin 1970; Lewis 1973; Riesenberg 1972.

22. There are a large number of references on this topic including Benedict 1975; Hocart 1952; Sahlins 1976:24-46; Mosko 1985; Eyde 1983; Force and Force 1961; McKnight 1960; Riesenberg 1968; and Alkire 1970, 1972.

23. Alkire 1970.

24. Eyde 1983.

25. Alkire 1968a, 1968b, 1970, 1980, and especially 1982.

26. See McKnight 1960, Force 1960, Force and Force 1961, and Barnett 1960.

27. Riesenberg 1968.

28. Schneider 1962, Labby 1976 and Lingenfelter 1975.

29 See Goodenough 1951 and Alkire 1977:58-59.

30. Fujimura and Alkire 1984.

31. Alkire 1965, 1980.

32. Spoehr 1954.

33. Lessa 1962; Hezel 1983.

34. See Semper 1982; Cheyne 1852; Shineberg 1971; and Tetens 1958.

35. Spoehr 1960.

36. Riesenberg 1968.

37. The Marianas are the best example for this.

38. See Hezel 1982, 1984. The wide-spread importance of knowledge in Oceania is discussed by Lane 1977; Lindstrom 1978, 1982, 1984; Alkire 1980.

39. Tambiah 1976:365-400, discusses an interesting parallel in modern Thailand.

BIBLIOGRAPHY

Alkire, William H. 1960. "Cultural adaptation in the Caroline Islands." *Journal of the Polynesian Society*, 69:123-150. Wellington.

Alkire, William H. 1965. *Lamotrek Atoll and Inter-island Socioeconomic Ties*. Illinois Studies in Anthropology, No. 5. University of Illinois Press: Urbana.

Alkire, William H. 1968a. "Porpoises and Taro." *Ethnology*, 7:280-289.

Alkire, William H. 1968b. "An Atoll Environment and Ethnogeography." *Geographica*, 4:54-59. Kuala Lumpur.

Alkire, William H. 1970. "Systems of Measurement on Woleai Atoll, Caroline Islands." *Anthropos*, 65:1-73.

Alkire, William H. 1972. "Concepts of Order in Southeast Asia and Micronesia." *Comparative Studies in Society and History*, 14:484-493.

Alkire, William H. 1974a. "Land Tenure in the Woleai." In H.P. Lundsgaarde, ed., *Land Tenure in Oceania*, pp. 39-69. University Press of Hawaii: Honolulu.

Alkire, William H. 1974b. "Native Classification of Flora on Woleai Atoll." *Micronesica*, 10(1):1-5.

Alkire, William H. 1977. *An Introduction to the Peoples and Cultures of Micronesia*. Second edition. Cummings Publishing Co.: Menlo Park, Calif.

Alkire, William H. 1978. *Coral Islanders*. AHM Publishing Corp.: Arlington Heights, Illinois.

Alkire, William H. 1980. "Technical Knowledge and the Evolution of Political Systems in the Central and Western Caroline Islands of Micronesia." *Canadian Journal of Anthropology*, 1:229-237.

Alkire, William H. 1981. "Traditional Exchange Systems and Modern Political Developments in the Yap District of Micronesia." In R.W. Force and B. Bishop, Eds., *Persistence and Exchange*, pp. 15-23. Pacific Science Association: Honolulu.

Alkire, William H. 1982. "The Traditional Classification and Treatment of Illness on Woleai and Lamotrek in the Caroline Islands, Micronesia." *Culture*, 2:29-41.

Alkire, William H. 1984a. "Central Carolinian Oral Narratives: Indigenous Migration Theories and Principles of Order and

Rank." *Pacific Studies*, 7:1-14.

Alkire, William H. 1984b. "The Carolinians of Saipan and the Commonwealth of the Northern Mariana Islands." *Pacific Affairs*, 57:270-283.

Ayres, William S., A.E. Haun, and C. Severance. 1979. *Settlement and Subsistence on Ponape, Micronesia.* Interim Report 79-2. University of Oregon: Eugene.

Bargatzky, Thomas. 1984. "Culture, Environment, and the Ills of Adaptationism," *Current Anthropology*," 25:399-415.

Barnett, Homer. 1960. *Being a Palauan*. Holt: New York

Barrau, Jacques. 1961. *Subsistence Agriculture in Polynesia and Micronesia.* Bishop Museum Bulletin 223. Bishop Museum Press: Honolulu.

Barrau, Jacques. 1965. "*L'humide et le sec*: an Essay on Ethnobiological adaptation to Contrastive Environments in the Indo-Pacific Area," *Journal of the Polynesian Society*, 74:329-46.

Bascom, W.R. 1948. "Ponape Prestige Economy," *Southwestern Journal of Anthropology*, 4:211-221.

Bayliss-Smith, Tim. 1974. "Constraints on Population Growth: the Case of the Polynesian Outlier Atolls in the Precontact Period," *Human Ecology*, 2:259-295.

Benedict, Paul. 1975. *Austro-Thai Language and Culture.* HRAF Press: New Haven.

Bryan, E.H., Jr. 1971. *Guide to Place Names in the Trust Territory of the Pacific Islands.* Pacific Scientific Information Center, Bishop Museum: Honolulu.

Cheyne, Andrew. 1852. *A description of Islands in the Western Pacific Ocean. . .* Potter: London.

Craib, John L. 1983. "Micronesian Prehistory: an archaeological overview," *Science*, 219:922-927.

Davenport, William. 1960. "Marshall Islands Navigational Charts," *Imago Mundi*, 15:19-26.

Douglas, Bronwen. 1979. "Rank, Power, Authority: A Reassessment of Traditional Leadership in South Pacific Societies," *Journal of Pacific History* 14:2-27.

Dyen, Isidore. 1965. *A Lexicostatistical Classification of the Austronesian Languages.* International Journal of American Linguistics, Memoir No. 19. Indiana University Publications in Anthropology and Linguistics.

Eyde, David B. 1983. "Recursive Dualism in the Admiralty Islands." *Journal de la Societe des Oceanistes*, 39:3-12.

Force, Roland W. 1960. *Leadership and Cultural Change in Palau.* Chicago Natural History Museum, Fieldiana Anthropology, Vol. 50: Chicago.

Force, Roland W. and Maryanne Force. 1961. "Keys to Cultural Understanding," *Science*, 133:1202-1206.

Fosberg, Raymond R. 1963. "The Island Ecosystem," in F.R. Fosberg, ed., *Man's Place in the Island Ecosystem.* Pp. 1-6. Bishop Museum Press: Honolulu.

Fujimura, Keiko and William H. Alkire. 1984. "Archaeological Test Excavations on Faraulep, Woleai, and Lamotrek in the Caroline Islands of Micronesia." In Y. Sinoto, ed., *Caroline Islands Archaeology*, pp. 65-138. Pacific Anthropological Records, No. 35. Dept. of Anthropology, Bishop Museum: Honolulu.

Gifford, E.W., and D.S. Gifford. 1959. "Archaeological Excavations on Yap," *Anthropological Records*, 18:2. University of California: Berkeley.

Gladwin, Thomas. 1970. *East is a Big Bird.* Harvard University Press: Cambridge.

Goldman, Irving. 1970. *Ancient Polynesian Society.* University of Chicago Press: Chicago.

Goodenough, Ward. 1951. *Property, Kin and Community on Truk.* Yale University Publications in Anthropology, No. 46: New Haven.

Grace, George. 1961. "Austronesian Linguistics and Culture History," *American Anthropologist*, 63:359-368.

Heine, Carl. 1974. *Micronesia at the Crossroads.* East-West Center Book. University Press of Hawaii: Honolulu.

Hezel, F.X. 1982. *Reflections on Micronesia.* Working Paper Series, Pacific Islands Studies. Center for Asian and Pacific Studies, University of Hawaii: Honolulu.

Hezel, F.X. 1983. *The First Taint of Civilization.* Pacific Islands Monograph Series, No. 1. University of Hawaii Press: Honolulu.

Hezel, F.X. 1984. "Schools in Micronesia Prior to American Administration," *Pacific Studies* 8(1):95-111.

Hocart, A.M. 1952. *The Northern States of Fiji.* Royal Anthropological Institute Occasional Publication 11. London.

Hunter-Anderson, R.L. 1983. *Yapese Settlement Patterns: an Ethnoarchaeological Approach.* Pacific Studies Institute: Agana, Guam.

Hunter-Anderson, R.L. 1984. "Recent Observations on Traditional Yapese Settlement Patterns," *New Zealand Journal of Archaeology*, 6:95-105.

Hunter-Anderson, R.L. and Yigal Zan. 1985. "'Where's the Fish?' or, What Limited the Size of Aboriginal Populations in Small Tropical High Islands?," *Journal of the Polynesian Society* 94:61-65.

Kirch, Patrick V. 1984. *The Evolution of the Polynesian Chiefdoms.* Cambridge University Press: Cambridge. Pp. 152-194.

Labby, David. 1976. *The Demystification of Yap.* University of Chicago Press: Chicago.

Lane, R.B. 1977. "Power Concepts in Melanesia and Northwestern North America," Chapter 28 in *The Anthropology of Power* ed. by R. Fogelson and R. Adams, pp. 365-374. Academic Press: New York.

Lessa, William A. 1950. "Ulithi and the Outer Native World." *American Anthropologist*, 52:27-52.

Lessa, William A. 1961. *Tales from Ulithi Atoll.* University of California Press: Berkeley.

Lessa, William A. 1962. "An Evaluation of Early Descriptions of Carolinian Culture," *Ethnohistory*, 9:313-404.

Lewis, David. 1973. *We, the Navigators: The Ancient Art of Landfinding in the Pacific.* University Press of Hawaii: Honolulu.

Lindstrom, Lamont. 1978 (1981). "Bigman or Chief? Knowledge and Political Process on Tanna," *Kroeber Anthropological Society Papers* 57/58:122-146.

Lindstrom, Lamont. 1982. "Leftamap Kastom: The Political History of Tradition on Tanna, Vanuatu," *Mankind* 13(4):316-329.

Lindstrom, Lamont. 1984. "Doctor, Lawyer, Wiseman, Priest: Big-Men and Knowledge in Melanesia," *Man* 19(2):291-309.

Lingenfelter, S.G. 1975. *Yap: Political Leadership and Culture Change in an Island Society.* University Press of Hawaii: Honolulu.

Mahony, Frank J. 1970. *A Trukese Theory of Medicine.*

Unpublished Ph.D. thesis, Stanford University (University Microfilms International, BWH 70-18439).

McKnight, R.K. 1960. *Competition in Palau.* Unpublished Ph,.D. thesis. Ohio State University.

Marshall, Mac. 1979. *Weekend Warriors.* Mayfield: Palo Alto, Ca.

Marshall, Mac. 1984. "Structural Patterns of Sibling Classification in Island Oceania: Implications for Culture History," *Current Anthropology*, 25:597-637.

Marshall, Mac (ed.). 1981. *Siblingship in Oceania.* ASAO Monograph No. 8. University Press of Hawaii: Honolulu.

Mason, Leonard. 1974. "Unity and Disunity in Micronesia: Internal Problems and Future Status," in D.T. Hughes and S.G. Lingenfelter, eds., *Political Development in Micronesia,.* pp. 203-262. Ohio State University Press: Columbus.

Mosko, Mark S. 1985. *Quadripartite Structures: Categories, Relations, and Homologies in Bush Mekeo Culture.* Cambridge University Press: Cambridge.

Murphy, R.E. 1949. "'High' and 'Low' Islands in the Eastern Carolines," *Geographical Review*, 39:425-439.

Oliver, Douglas L. 1961. *The Pacific Islands.* Harvard University Press: Cambridge.

Osborne, Douglas. 1966. *Archaeology of the Palau Islands: An Intensive Survey.* B.P. Bishop Museum Bulletin 230. Bishop Museum Press: Honolulu.

Reinmann, Fred R. 1977. *An Archaeological Survey and Preliminary Test Excavations on the Island of Guam, 1965-1966.* MARC: Guam.

Riesenberg, Saul. 1968. *The Native Polity of Ponape.* Smithsonian Contributions to Anthropology, No. 10: Washington, D.C.

Riesenberg, Saul. 1972. "The Organization of Navigational Knowledge on Puluwat," *Journal of the Polynesian Society*, 81:19-56.

Ritter, Philip. 1978. *The Repopulation of Kosrae: Population and Social Organization on a Micronesian High Island.* Unpublished Ph.D. thesis. Stanford University.

Sahlins, Marshall. 1976. *Culture and Practical Reason.* University of Chicago Press: Chicago.

Introduction," in Herman R. Friis, ed., *The Pacific Basin: a History of its Geographical Exploration.* American Geographical Society: New York. Reprinted (1968) in A.P. Vayda (ed.) *Peoples and Cultures of the Pacific.* Natural History Press: New York.

Tobin, Jack A. 1953. "An Investigation of the Socio-Political Schism on Majuro Atoll," mimeographed: Majuro.

Wiens, H.J. 1962. *Atoll Environment and Ecology.* Yale University Press: New Haven.

Wilson, Walter Scott. 1968. *Land, Activity and Social Organization of Lelu, Kusaie.* Unpublished Ph.D. thesis, University of Pennsylvania.

Background Paper 4

IMPLICATIONS OF HISTORY AND CULTURE FOR SUSTAINING DEVELOPMENT OF RENEWABLE RESOURCES ON U.S.-AFFILIATED PACIFIC ISLANDS

by

Robert C. Kiste
Pacific Islands Studies Program
University of Hawaii

1986

Prepared for

U.S. Congress, Office of Technology Assessment,
Integrated Renewable Resource Management for U.S. Insular Areas,
Washington D.C.: U.S. Government Printing Office, 1987.

ABSTRACT

This paper reviews the cultures and histories of Pacific Islands that are affiliated with the U.S. with reference to their relevance for the management and development of renewable resources. The settlement of Pacific Islands and the cultures of the islands, with emphasis upon their adaptations to different island ecosystems, is reviewed first. The theme of cultural diversity is stressed.

The post-European contact era in Micronesia is considered. This includes early European contact in Micronesia, and the subsequent German and Japanese colonial periods and their impacts on island societies.

U.S. administrations are next reviewed, and these began with Guam and American Samoa at about the turn of the century. Navy rule during the four decades up to World War II are reviewed, and the impact of the war on Guam, American Samoa, and Micronesia is discussed.

In the early 1950s the Department of the Interior replaced the navy in the Pacific. The initial decade under the new administration brought little change. However, the beginning of the 1960s witnessed major transformations. A tourist industry and tuna canneries had great impacts on Guam and American Samoa respectively. Particularly important for the Trust Territory, federal funds and programs became widely available to the territories, and as one result, the new political entities emerging from the Trust Territory are extremely dependent on the United States.

Today, all of the U.S. affiliated islands are dependent on outside forces (tourists, businesses, and federal funding), and there is little interest or concern with the management and development of renewable resources. The post-European era has been one of movement away from self-sufficiency and towards dependency.

INTRODUCTION

This study is concerned with the U.S. affiliated Pacific Islands of American Samoa, Guam (the southernmost of the Mariana Islands) and the U.S. Trust Territory of the Pacific Islands (TTPI). Within the latter, four political entities are emerging. First, the Northern Marianas will become a U.S. Commonwealth. The other three will probably enter into a self-governing status in "free association" with the U.S. This new political status has been described elsewhere (Kiste, 1983a), and the three entities are: The Republic of the Marshall Islands; the Republic of Belau (formerly Palau), and the Federated States of Micronesia (FSM). The latter is comprised of four states: Yap, Truk, Pohnpei (formerly Ponape), and Kosrae (formerly Kusaie). Collectively, Belau and the states of the FSM are also known as the Caroline Islands. Map I portrays the "New Pacific."

The traditional island cultures differed greatly. American Samoa is located in Polynesia. Guam and the islands of the TTPI form most of Micronesia. (The independent nations of Kiribati, formerly the Gilbert Islands, and Nauru are also part of Micronesia but they were never American territories.) Within Micronesia, there is also considerable cultural diversity, especially between societies on high islands and those on low coral atolls. Map II outline's the Pacific's culture areas.

In addition to cultural diversity, the islands have had varied colonial histories. American Samoa has had only one colonial master; it became an American possession in 1900. In contrast, Spain laid claim to most of Micronesia as early as the 1600s. After the Spanish-American war, Guam became an American possession in 1898 and the rest of Spanish Micronesia came under German rule. Germany was replaced by Japan with World War I, and Japan was replaced by the U.S. during World War II. This is the part of Micronesia which became the TTPI. In contrast to American Samoa and Guam, it has never been a possession of the U.S. Rather, it has been administered since 1947 as a trusteeship within the framework of the United Nations (U.N.).

In spite of their differences, all U.S. islands have something in common. U.S. policies have often not been appropriate to island cultures and needs. Federal programs and subsidies have seriously eroded self-sufficiency and have made the islands dependent upon American largess. Such dependency is both psychological and material; and it inhibits any effort to develop and manage the islands resources.

HISTORY OF RESOURCE USE

PRE-EUROPEAN ERA

The ancestors of Pacific peoples originated from Southeast Asia, and more particularly, island Southeast Asia. Western Micronesia—the Marianas, Yap, and Belau—was settled by migrants directly from the southeast. The ancestors of eastern Micronesians and Polynesians skirted across northern Melanesia 4,000 years ago. Arriving in the area of present day Vanuatu, some moved north into eastern Micronesia, and others continued into Polynesia. All Micronesians and Polynesians speak languages which belong to the Austronesian language family, and it has Southeast Asian origins (Bellwood, 1979).

The numbers of species of plants and animals were never great, and they decrease in number as one moves from west to east (Bellwood, 1979). Most plants important for subsistence were carried into the islands by the migrants (Bellwood, 1979). Pigs, dogs, and chickens may also have been intentionally introduced.

Most agriculture involved food bearing trees and root crops. Among the former were the all important coconut palms (which provided food, drink, and building materials) and breadfruit, papaya, bananas, and pandanus. Root crops included wet and dry land varieties of taro, yams, sweet potatoes (an exception to the Southeast Asian origins of subsistence plants), and arrowroot. Cultivated stimulants were restricted to betal nut (chewed in western Micronesia) and kava (prepared as a drink in Samoa and two places in eastern Micronesia where it is known as sekau). Both are mild narcotics; neither produce significant harmful side effects.

Agricultural terraces like those of Southeast Asia were found in the Marianas and Belau (Bellwood, 1979). Their use, however, was discontinued by the time of European contact, and it appears that those in the Marianas were for rice cultivation.

Several species of trees were used for dwellings and canoes. Pandanus leaf thatch provided excellent material for canoe sails and thatch for houses. Coconut fronds provided a thatch of a poorer quality. All tools and fishhooks were fashioned from locally available wood, shell, stone, and coral.

Marine resources were important everywhere. Trolling from canoes was conducted in the open ocean, and canoes were also used for fishing within sheltered lagoons. Nets, traps, weirs, and spears were also used. The lagoons of the atolls supported a wide variety of reef fish, and turtles, lobsters, and shellfish were collected.

Everywhere, islanders had a vast knowledge about the local flora and fauna. The behavior, movement patterns, and mating habits of marine creatures varied with monthly and annual cycles, and these were known in great detail. Recent research in Belau has revealed that the traditional body of knowledge was more sophisticated and comprehensive than that of today's marine biologists (Johannes, 1981).

TRADITIONAL CULTURES

There is a fundamental difference between the ecologies and resource bases of high islands and coral atolls, and this was reflected in traditional cultural systems. The high islands have the largest land masses, the best soils, and fresh water sources. They support the greatest variety and number of plants and animals, and they have always had the largest human populations. In the settlement of the Pacific, the high islands were occupied first (Bellwood, 1979).

In sharp contrast, an atoll is a series of islets that rest upon a coral reef and enclose a central lagoon. The islets of an atoll are seldom more than 10 to 15 feet above high-tide level, and land areas are dwarfed by lagoon areas. Soil covers are poor and extremely thin, and the only fresh water that is available is rainwater that is either collected or, on some of the larger islands, floats as a thin and fragile lens beneath the soil and above the denser salt water that permeates the porous coral rock (Kiste, 1984:8).

Some atolls provide only marginal terrestrial resources for human existence, and their inhabitants have no choice but to rely upon marine resources. For example, the atolls of the northern Marshalls have unusually poor soil covers, and they lie within a relatively dry zone. The only crops are coconuts, pandanus, and arrowroot. None require much care after initial planting, and the people are essentially gatherers of limited land resources who rely mainly on marine life.

Furthermore, atolls are extremely vulnerable to typhoons, unusually high seas, or droughts; and, unfortunately, most of Micronesia is situated in a typhoon belt. Typhoons are most common between July and November, with the highest frequency in September. They generally originate between the Marianas and the Marshalls. However, they are most common between Yap and Guam, but at rare intervals one strikes as far east as Kiribati (Manchester, 1951:239).

In contrast, American Samoa consists of five volcanic islands and only two atolls, one of which is uninhabited. Samoa is situated outside the paths of frequent storms and has abundant rainfall. The environmental challenge is less, and there is little, if any, anxiety about natural calamities.

Several facets of Micronesian cultures may be interpreted as adaptations to their ecological settings, i.e., small islands with limited resources and vulnerability to natural disasters. It is not surprising that in Micronesia, land is conceived of as the most valued resource. Control over land was tantamount to political power, and land tenure was directly related to systems of social stratification and elaborate chieftainships.

For most of Micronesia, the systems of social organization and land tenure were based on matrilineal descent. Islanders were divided among matrilineages and matriclans. Lineages and clans were ranked, and their was a basic division between paramount chiefs, lesser chiefs, and commoners (Alkire, 1977).

The lineage was the landholding unit, and it was an extended kin group with a depth of three to five generations. At birth, an individual became a member of his or her mother's matrilineage and acquired the right to live on and share the resources of the lineage's land. Authority over lineage members and its land resided with the lineage's senior ranking male (usually the eldest).

Aggregates of lineages which shared the same name formed the next larger social unit, the matriclan. Lineages belonging to the same clan were scattered throughout an island group and were thought to be blood-related, but in most instances, actual genealogical connections were unknown. Clans were exogamous and were a medium for the provision of hospitality; islanders were obliged to protect and care for a fellow clansman, whether he or she were a stranger or friend. As clan members were dispersed, the clan functioned as a social security net. One could find assistance from clansmen when engaged in sailing expeditions or in time of need.

In most areas, certain lineages (or sometimes clans) were chiefly in rank. Their heads were paramount chiefs and junior ranking males of the chiefly line served as lesser chiefs. The domain of a paramount chief might be a section of a high volcanic island or several islands in a group of atolls. In the Marshalls, Pohnpei, Kosrae, the Marianas, and to a lesser extent Belau, paramount chiefs were extremely powerful. They had life or death powers over their subjects, had final disposition over land, and received tribute from their subjects. Where lesser chiefs existed, they served as administrators over portions of the paramount chief's domain. Warfare was constant in the entire area as chiefs fought to extend their respective domains.

Paramount chiefs had crucial functions with regard to the management of land and resources. Chiefs were obligated to protect and care for commoners within their realms. This was especially crucial in the Marshalls; in this group of all atolls, paramount chiefs provided relief supplies and relocated people when necessitated by drought or typhoons.

At any given time, some lineages were expanding while others were declining due to differential female fertility rates: lineages readily doubled or halved their memberships in the space of one or two generations (Goodenough, 1955:80). As a consequence, there were continual disparities between the sizes of lineages and the amount of land they required. While there was some flexibility in the system (e.g., the land wealthy could allow use privileges to land-poor relatives), the paramount chiefs occasionally had to exercise their powers to bring about redistributions of land. Thus, like the system of matrilineal clans, paramount chiefs played important roles in the provision of assistance and security. They looked after their subjects in times of need, and occasional redistributions of land also helped maintain a balance between the sizes of lineages and the allocation of resources.

While the clan system of hospitality was almost identical with the rest of Micronesia, the Carolinian atolls between Yap in the west and Truk in the east represented an exception to the stratified social systems of rest of Micronesia. For example, each atoll or section of a larger island in Truk lagoon was a politically autonomous community. Within each, lineages were ranked according to the common ancestor's arrival and settlement on the island. The lineage with the greatest antiquity had the greatest seniority, and its head was the community's chief. His powers, however, were limited, and he consulted with other lineage heads before making any important decision.

The Carolinian atoll dwellers, however, had developed other methods of cultural adaptation to the exigencies of atoll life. In several instances, nearby communities were linked in exchange relationships and could expect assistance from their partners in a time of need. On a larger scale, the exchange system known as sawei once linked Yap to all the atolls from Ulithi (near Yap) in the west to Namonuito (near Truk) in the east (Alkire, 1977:50-51).

Under the sawei system, a fleet of canoes from the atolls carried an annual tribute to Yap. The tribute was rendered to Yapese hosts, and later, when the atoll dwellers set sail for home they were given food and other gifts. Traditionally, it was believed that the tribute was rendered to Yap because Yapese magicians could either protect the atoll dwellers or send destructive storms and typhoons.[1] In reality, and as Alkire has noted, the system "linked the people of a number of small, vulnerable, and dispersed islands situated in a typhoon zone of the western Pacific in a way that permitted members of these ranked societies to move freely between islands, and to request and expect aid from any other island within the system in case of disaster and shortages" (Alkire, 1977:52).

In contrast, Samoans had a much more flexible social system than the lineage organization of Micronesia. The largest unit was the aiga, and it included all those people who could trace descent from the founder of the group. Descent could be traced through males or females, and any given individual belonged to a number of aiga. The aiga held land in a particular village, and each had one or more matai, chiefly titles or positions. The matai were selected by consensus by the aiga membership. The matai of a village formed its governing council or fono.

An individual could live on and work the land of his or her aiga, and since each individual belonged to several, a choice had to be made where one actualized his or her potential rights. Thus, resident aiga members, their spouses, their children, some of their children's children, etc. formed localized extended families which resided on aiga land.

It has been argued that descent groups like those of Samoa "are associated with an ecology wherein resource zones are not widely separated, but are clustered such that all domestic groups can engage in the entire range of production activities" (Sahlins, 1971:49). They occur on islands like Samoa "where narrow zones of exploitation concentrate near the coast. All resources being accessible, small groups tend to be self-sufficient and population nucleates in village form" (Sahlins, 1971:49).

POST-EUROPEAN CONTACT

EARLY EUROPEAN CONTACT IN MICRONESIA

The European era in the Pacific began in Micronesia when Magellan discovered Guam in 1521. It was not until 1668, however, that the Spanish established on Guam the first European colony in the Pacific. It was composed of soldiers and priests. The Catholic missionization of the local Chamorro people began, and armed conflicts led to the Chamorro-Spanish wars (Furnas, 1948). As mentioned, the Chamorro population was reduced to a few thousand, and most of the people were moved to Guam. Traditional Chamorro culture was essentially destroyed, but the language lives on in altered form.

While the Spanish claimed most of Micronesia, they did not attempt to extend actual rule outside of the Marianas until other nations, particularly Germany, attempted to gain a foothold in the region. In the 1890s, Spain attempted to establish its authority over Pohnpei, but the small garrison there was never successful (Crawford, 1967).

Decades before the Spanish move to Pohnpei, other influences had been at work in the east. American and English whaling vessels began to arrive in the 1830s. The whaling industry thrived during the next two decades, and Pohnpei and Kosrae became favorite ports of call. Islanders became involved in the larger world trade as they exchanged food, water, other supplies, and women for imported goods, and the desire for foreign things and dependency on the outside world had its beginnings.

Whaling declined in the 1850s, but two other agents of change arrived. American Protestant missionaries from Hawaii began their work in the east, and copra traders (actually, the trade was initially in coconut oil) set up their enterprises. Both had great impacts. Eventually, Christianity was firmly embraced by most Micronesians, and conflicts between Protestants and Catholics were common. The presence of the copra traders meant that imported goods were more easily at hand, and the ecology of Micronesia was changed. Many islands that had had only a few palms became covered with the trees, and in some cases, other crops and hardwoods were replaced. Micronesia had entered what was later to be called the era of the "coconut civilization" (Oliver 1951), but few foreign-owned plantations were ever established and the land remained in indigenous hands.

GERMAN AND JAPANESE RULE IN MICRONESIA

Germany declared a protectorate over the Marshalls in 1885. The next political realignment came with the end of the Spanish-American war in 1898. Because of its harbor, the U.S. took Guam, and Germany purchased the rest of Spanish Micronesia. Thus, Germany came to possess the islands which currently form the TTPI.

Germany's rule was brief. It ended with the outbreak of World War I when Japan occupied the islands. During their era, the Germans were primary concerned with making the colony profitable. The copra trade was expanded; little was spent for administration. A system of "indirect rule" was employed as the Germans ruled through the hereditary chiefs.

On Pohnpei, the Germans experienced a rebellion, and in response they tried to break the back of Pohnpei culture. Land was taken away from the matrilineages, and parcels were assigned to males who were instructed that land would henceforth be inherited by their own offspring and not those of their sisters (Fischer, 1970).

Japan's rule of about three decades, 1914 to World War II, differed considerably from that of Germany, and Japan's impact on the islands was much greater. Japan had several explicit goals: 1) Micronesia was to be used to drain excess population from Japan; 2) economic development was to be pursued on multiple fronts; 3) the islanders were to be Nipponized; and 4) other nationalities were to be kept out (Heine, 1974). Eventually, the strategic value of the area was to be utilized in the events that culminated in World War II.

Japan administered by "direct rule," appointing its own officials, and in terms of its own goals, it was largely successful. As noted, Japanese nationals came to outnumber the islanders. Economic development occurred on an unprecedented scale. The copra trade was further expanded. Commercial fishing became of greater economic importance than copra. A sugar industry was developed in the Marianas. Phosphate was mined in Belau, and a variety of smaller industries were developed. Compulsory education for islanders was brief (three years), but effective. Many learned conversational Japanese and a familiarity with Japanese culture (Nevin, 1977).

During this period, islanders continued to be the primary producers of copra, and most remained subsistence villagers. They benefited from the copra trade, and became more accustomed to the luxuries of imported goods. Some learned new skills associated with Japanese industry, but in terms of traditional skills, Micronesians could have returned to their former ways of life.

Obviously developments during the Japanese period were for the benefit of Japanese, but there were important social and psychological consequences for Micronesians. They became accustomed to an authority imposed from the outside with decreased say over their own affairs. Traditional authority was greatly weakened.

U.S. ADMINISTRATION

NAVY RULE IN GUAM AND AMERICAN SAMOA

Guam and American Samoa had certain similar colonial experiences. Both became U.S. possessions at about the same time because America coveted their harbors. Further, both were administered by the U.S. navy for about the same length of time. In other ways, however, the two were quite different.

During the long era of Spanish rule, the Chamorros of Guam had devised a new cultural adaptation to their environment, and it continued without disruption with American rule. A navy officer replaced the Spanish governor as the head of the political system, and the Chamorro community remained intact with the Catholic church at its center. Individual families (as opposed to lineages) had their own lands and were self-sufficient subsistence farmers and copra producers. Some employment was available with the navy.

Before World War II, Guam was a sleepy backwater in the boondocks. The Navy ruled with a firm hand, and the community was dual in nature: the military and the Chamorro (University of Guam, 1975:IV 94-95). The latter were in the majority, and they were reminiscent of Spanish peasantries in Latin America and the Philippines. In this respect, Guam was unique in the Pacific.

In contrast, the Samoans had no colonial masters prior to the U.S. Navy, and European contact had not altered the basic fabric of Samoan life. Europeans had begun to arrive in the late 1700s, and missionization commenced in the 1830s. By the 1850s, Americans, English, and Germans were competing to acquire land for copra plantations. They wanted a central government which would protect their interests, but they were frustrated by the Samoans (Gray, 1960).

In Samoa, each village with its constituent aiga was the primary social unit, and one's allegiance was devoted to these localized residential units. Thus, Samoans were fragmented among their many villages, and there were no paramount chiefs or overarching political authority. From the standpoint of Europeans, Samoan social organization provided no easy means of dealing with or manipulating the local populace. The Samoans went about their business as usual, and again from the outsiders' viewpoint, things were made even more chaotic by the frequency of local warfare.

On several occasions, the Europeans attempted to form governments headed by puppet Samoans, but all were failures. In 1899, the three powers divided Samoa. The U.S. took Tutuila, with its harbor at Pago Pago, and the Manua group. The lion's share, Western Samoa, went to Germany, and England received concessions elsewhere. In 1900, the American flag was raised over Pago Pago, and Navy rule began (Gray 1960:101-110)

From the turn of the century until World War II, the style of Navy rule was similar to that on Guam. The Navy administered in a manner calculated to perpetuate the status quo. Some Samoans were employed by the Navy, but for the most part, the Samoan way of life continued intact until World War II (Van Cleve, 1974:65).

WORLD WAR II

Three days after Pearl Harbor, Japan invaded and occupied Guam. The occupation lasted two and a half years, and the Guamanians suffered greatly. The capital of Agana was destroyed, and after the war the U.S. military establishment on the island was greatly expanded. Many Chamorros found employment, and subsistence agriculture all but disappeared (University of Guam, 1975:IV 3-4).

In American Samoa, the war also brought major changes, and life on Tutuila was monumentally disrupted. Pago Pago became a staging base. Young Samoan males worked for the military there, and others travelled to Pearl Harbor to work. Others enlisted in the Navy. A great amount of cash was pumped into the economy. People were drawn away from traditional pursuits (Gray, 1960), and for a population of only 13,000 or so (see Table III), the impact was great.

As noted, World War II also brought American rule to Micronesia. The first American invasion occurred in Kiribati in 1943, and the Marshalls were next. After they were secured, the Marianas were the next target and the islands in between were skipped over. Shipping between Japan and Micronesia was cut off, and the economy of the islands collapsed. People were forced to revert to subsistence agriculture, and in areas where there were large concentrations of Japanese troops, they and the islanders competed for existence (Fischer, 1970). Conditions were harsh, and human suffering was great.

POST-WAR SAMOA

In 1951, the administration of American Samoa was turned over to the Department of Interior, and the Navy closed its base. A panic set in. Samoans had clearly come to prefer a cash economy, and although it had formerly been their primary economic activity, a subsistence economy was shunned (Gray, 1960). Samoans voted with their feet, and many migrated to Hawaii and the west coast.

There was a turn-around in the early 1950s when Van Camp opened a tuna cannery. Van Camp's success resulted in a second cannery in 1963 operated by Star Kist. Also in the early 1960s, two other events had irreversible impacts on American Samoa. First, federal funding became more generous and a wide variety of federal programs, many of which were part of President Johnson's "Great Society," were made available to the American territories and led to substantial dependency on Washington, D.C. Secondly, television was introduced for educational purposes, but within a short time, popular programming became available, and it served to create new wants and needs.

Today, while many families have gardens, Samoans are largely involved in a money economy, and the relevance of renewable resources is slight. Samoans purchase 75 percent of their food requirements (American Samoan Government, 1981). The largest employer is the American Samoa Government (ASG), the canneries are second, and a range of retail and service enterprises comprise the third **major** portion of the economy. Remittances from relatives working abroad make a substantial contribution (American Samoan Government, 1981), but no accurate figures are available.

The 1983 estimation of American Samoa's population was 33,000. Of these, about one-half were under 14 years of age. Of the 16,500 age 14 or older, the labor force was estimated at about 10,000, and 9,536 were actually employed. Of the latter, 43 percent of 4,124 worked for the ASG. In the private sector, 5,412 were employed. One-third of this number were in the canneries. (U.S. Department of Labor, 1983)

A small tourist industry (about 20,000 visitors per year) makes a small contribution to the economy. Further development of tourism is hampered by inadequate and always changing air service to Samoa. With better air service and proper promotion, the natural beauty of Samoa could be marketable resource.

As an indication of American Samoa's dependency on federal funds, the budget of ASG in fiscal year 1980 was almost $73 million. Of this, slightly less than half, about $32 million, came from federal sources (American Samoan Government, 1981).

POST-WAR GUAM

Guam was turned over to the Department of Interior in 1950, one year earlier than American Samoa. The increased military presence after the war created more employment, but major changes occurred in the 1960s. As elsewhere, federal funds and programs became more easily available. In the early 1960s, however, the largest single input of federal funds came after disaster. In November 1962, a typhoon hit Guam with devastating force. About 80 percent of all homes and buildings were demolished or severely damaged.

Funds in the amount of $75 million were provided, and a construction boom larger than that after the war was launched (Van Cleve, 1974:90).

A few years later, a tourist industry began to grow, and it quickly became a chief ingredient in the economy. In 1967, Guam had 4,500 visitors. Within three years the number reached 58,000, and in 1971 these were 119,000 (Van Cleve, 1974:91). By 1982, tourists had increased to 326,341. Reflecting its location in the western Pacific, the vast majority (83.5 percent) of Guam's tourists are from Japan (Economic Research Center, 1983:Table 5).

In 1982, Guam's population was 108,406. Since World War II, the increase of military strength, heavy in-migration (especially the Philippines and the U.S.), and out-migration to the U.S. all contributed to a distortion in Guam's age and ethnic composition (Economic Research Center, 1983:7). Slightly less than half of the population was ethnic Chamorro. They numbered about 50,000, and another 32,000 were reportedly on the mainland.

Of Guam's 1982 population, approximately one-third (37,000) were under 15. This left roughly 71,500 age 15 or older. Of these, 10,836 are individuals on active military duty. (They had 8,653 dependents on island.) Half of all civilian employers were in the public sector. They numbered 35,000 (21,000 were employed by the Government of Guam, and 14,000 with federal employers). Another 850 were employees of the public-owned utility services. Tourism is estimated to employ 5,000 (Economic Research Center, 1983:14, 30).

The federal government occupies one-third of Guam which, in itself, would reduce agricultural potential. However, and like American Samoa, there is little government or private interest in agriculture. The 1983 Annual Economic Review reports that "primary agricultural production is declining," but no precise figures are given. Another source indicates that in 1980, "Only 200 were employed in agriculture" (Carter, 1984:179).

In fiscal year 1982, the Government of Guam's total operating revenues were $153.6 million. Of this, 77 percent came from locally collected taxes, 15 percent from U.S. agencies, 3 percent from federal grants, and 15 percent was from taxes paid by federal employees (University of Guam, 1975). (All income taxes collected from federal employees, including the military, revert to the Government of Guam.)

Thus, the people of Guam have moved even further away from a direct dependence and reliance on local renewable resources than the Samoans. A joke current on the island today relates that Guam is the only place in the Pacific where people buy their coconuts with food stamps. The climate and lovely Tumon Bay where hotels are clustered are the most important renewable resources.

POST-WAR TTPI

Like American Samoa, the Navy relinquished control of the TTPI to the Department of Interior in 1951. The first decade thereafter was marked by indecisiveness. There was no clear notion as to what was to be done with the territory. Budgets were low; a ceiling of $7.5 million was established, and actual appropriations averaged less (Nevin, 1977). The U.S. military tested nuclear weapons in the Marshalls, and the C.I.A. used the Northern Marianas for special training operations. Little happened elsewhere. No plans were developed for the future, and war-devastated areas were not rehabilitated. No measures were taken to restore the economy (Kiste, 1983b).

Such remained the situation until the early 1960s. It was the period which has been characterized as being one of "benign neglect" or one in which the U.S. was guided by a zoo philosophy, i.e., an "ethnological zoo." In reality, there is no evidence that the U.S. had such a policy. Rather, it appears that as long as the military was satisfied, other government agencies were simply not interested in an area so remote from the U.S. and about which the American public was ignorant (Kiste, 1983b).

In the early 1960s, the U.S. came under severe criticism over the TTPI, and U.N. visiting missions deplored the lack of economic development (Kiste, 1983b). President Kennedy was embarrassed by the U.S. record, and in 1962 his administration decided to move. It was decided that education had to be improved, and a large-scale crash program was launched to hire American teachers. The overall budget for the TTPI was doubled to over $16 million (Kiste, 1983b).

Over the next several years, the TTPI received greater attention. Budgets were steadily increased reaching about $25 million by 1967 and $50 million by 1970. By the end of the 1970's, the annual TTPI budget had reached $100 million, and 166 separate programs were in operation at a cost of an additional $30 million annually (Kiste, 183b). There was, however, no coordination among them, and they included such inappropriate items as large scale and unneeded food subsidy programs, financial aid to the elderly (in societies which revere and provide for elders), and job training programs designed for the disadvantaged in urban America.

With the exception of the Northern Marianas which, like Guam, has developed a thriving tourist industry, all the above measures were accompanied by a continued neglect of any real economic development which would allow Micronesians any degree of self-sufficiency. Indeed, the TTPI's crash programs and the federal welfare efforts had the very opposite effect:

Micronesians flocked to the administrative centers to gain employment with government agencies and to take advantage of welfare programs. Today's urban shanty towns are the lasting result, and half of all Micronesians are residing in them (U.S. Department of State, 1984). Quite often, outer islands are depopulated, and those who remain are the aged and some of the very young (grandchildren left with grandparents). Such populations often do not have a sufficient work force to maintain themselves properly.

The massive educational effort has generally been poor in quality. It produced a plethora of liberal arts majors, but few individuals with the technical skills or interest to maintain public services or manage or develop renewable resources. Health systems are in shambles.

As the termination of the TTPI draws near, the emerging political entities are very dependent on continued support from the U.S. For fiscal year 1984, federal funds in support of the TTPI amounted to about $147 million (U.S. Department of State, 1984). This included funds from the Department of Interior, federal grant funds, and funds for capital improvement projects. Roughly, the figures for the new political entities were: the Marshalls, $[illegible] million; Belau, $17 million; the FSM, $93 million; and the Marianas, $23 million (U.S. Department of State, 1984). The financial dependency on the U.S. will continue for the Marshalls, Belau, and the FSM as the terms of the compacts of free association provide generous financial packages over the next 15 years. As a U.S. commonwealth, the Marianas will be eligible for federal programs that are now available to all states of the union.

Further contributing to Micronesia's dependency, many of the traditional means of providing security and assistance have lapsed, and hereditary chiefs have lost much of their authority to manage resources. Colonial governments, especially that of the U.S., have assumed the responsibility to provide relief in times of disaster. The sawei exchange system involving Yap and the Carolinian atolls no longer exists. The chief's function to provide for commoners in times of need has largely been relinquished, and they no longer have the authority to redistribute land and resources when disparities in size develop among landholding lineages. In short, much of the traditional adaptation has been lost, and Micronesians now depend on outside support. The rapidly increasing population may well even increase the depth of the dependency (See Appendix A).

IMPLICATIONS FOR CURRENT RESOURCE DEVELOPMENT AND MANAGEMENT

CURRENT STATUS OF RESOURCES

The inventory of renewable resources has not been reduced or increased in recent decades. The major concern revolves about coconut palms and copra—the main cash crop of much of the Pacific. This has been especially true of resource-poor Micronesia, and, to a lesser extent, American Samoa. Coconuts are fairly insignificant on Guam today.

Copra prices have always fluctuated widely on the world market, such that heavy dependence on copra as a mainstay of an economy is risk. In terms of actual buying power, copra has fallen in value over the past three decades, and there are no reason to be more optimistic about the future. While copra futures are uncertain, there is a serious problem pertaining to the quantity and quality of coconut palms. In both American Samoa and the TTPI, existing stands of coconut palms commonly date back a half century or more which represents the productive life span of the trees. The aged trees will soon become unproductive. There are no plans or serious efforts to replant, and considering the instability of copra prices and its decreased value, there is a question as to whether or not replanting is economically worthwhile.

CURRENT STATUS OF RESOURCE USE

No single policy or single set of policies and regulations can be made to fit all of the U.S. affiliated islands. As has been described, there was considerable cultural diversity in the region in pre-European times. Also, as described, colonial histories have been quite different. Today, a distinction would also have to be made between the urban and rural/outer island sectors of any one cultural group. These conditions prevail even in the smaller units of the islands, i.e., each of the four states within the FSM are quite different entities, and each have their urban and rural components.

Throughout much of the foregoing discussion, the point has been made that the inhabitants of the Pacific Islands have increasing moved from a reliance on local renewable resources to a desire for and a reliance upon imports. This process began early on in the initial stages of contact with Europeans, and it has continued ever since, especially in the U.S. affiliated islands since the 1960s.

The three territories considered here may be ranked according to their movement away from the use of local resources. Guam has the most developed economy in a Western sense and lives on imports. Its capital is complete with fast food restaurants such as McDonald's, Pizza Hut, etc. As noted, there is little commitment to local agriculture. American Samoa ranks second to Guam. Most families rely on wage-earning for their livelihoods and, as noted, 75 percent of foodstuffs are purchased. In both Guam and American Samoa, much more could be done with the development of local renewable resources, but there is little, if any, desire to do so.

The people of the TTPI are still the most involved with and reliant upon local resources, but a major difference exists between urban and rural/outer island dwellers. The Northern Marianas, Belau, the Marshalls, and the four states within the FSM were formerly administrative districts within the TTPI, and each had its district center. These are now the capitals of the emerging nations or states within the FSM, and, in addition, the Marshalls have a second urban area—Ebeye Island on Kwajalein Atoll where workers at the Kwajalein Missile Range now live. Two-thirds of all Marshallese live in the two urban areas, and one-half of all other Micronesians live in the urban areas of their respective states and nations (U.S. Department of State, 1984).

The urban dwellers of Micronesia purchase the bulk of their foodstuffs, and in some areas, they probably exceed the 75 percent figure mentioned for American Samoa. There are now second and third generations of individuals who have been born and/or raised in the urban centers, and there has been a definite loss of traditional skills. It is impossible to give accurate figures, but many young Micronesians would be extremely hard-pressed to provide for themselves in a traditional manner. They lack fishing and sailing skills, and many have never been involved in agriculture.

In communities on outer islands, traditional skills still live, and on a very few of the remote atolls in the Carolines, near traditional lifestyles still exist. These are exceptions, however, and attempts on the part of local governments to lure people back to or have them remain in rural/outer island communities are only half-hearted and failures at best. The trend towards greater urbanization and loss of traditional skills appears to be quite irreversible.

Implicit in much of the above discussion is a consideration of the islanders' perceptions of types of resource values. Cash or the cash value of commodities is becoming increasingly important in all the American affiliated islands. The subsistence value alone of products is not held with high esteem. With regard to traditional values, however, food is extremely important for most social occasions. In the past, as in the present, no gathering of people is complete or proper without a sharing of food. Traditionally, certain foods, e.g., turtles, certain parts of fish or pigs, had prestige value. Today, imported meats and canned fish have much of this value.

CONCLUSION

The incentives for economic development are obviously the greatest in the more Westernized societies such as Guam and the Northern Marianas. Economic development, however, may well be a quest for the "fast buck" with no real regard for a longer range view and a concern for a sustained management of renewable resources in an ecologically sound manner. Indeed, there is more evidence for the former than the latter among the Chamorros of Guam and the Northern Marianas and the inhabitants of urban places.

At the opposite end of the continuum, in the more traditional societies, it cannot be said that there is any special or conscious concern for the management and development of renewable resources. The cultural adaptation that had evolved prior to European times was one that was in harmony with the environment, and there seemed to be a good balance between human populations and their ecological niches. Like the social arrangements internal to the _sawei_ exchange system, which provided a social security network, the traditional adaptation has been broken. At the same time, there appears to be little awareness that populations are increasing, coconut palms are becoming morbid, and old skills are being lost.

The continued diversity is evident when traditional decision making structures are considered. Not surprisingly, in Guam and the Northern Marianas, traditional structures disappeared long ago, and elected governors and legislators are now the main policy makers.

In American Samoa, there is a combination of traditional and modern decision making. The powers of the matai have decreased somewhat, but they remain strong shapers of opinion, and the upper house of the legislature is composed of matai elected by matai. The lower house is elected from the populace at large as is the governor.

In the Republics of Belau and the Marshalls, traditional chiefs have no guaranteed role in the introduced political structures, but they have considerable influence over local elections. The best of all possible worlds is to combine hereditary office with elected office. The President of the Marshalls is currently attempting to acquire a paramount chieftainship, and the highest ranking chief in Belau is involved with the electorate political process. Within the FSM, Pohnpei and Kosrae are somewhat like Belau and the Marshalls. Yap is very conservative; the chiefs remain strong and the elaborate caste and class system still provide the sociological framework in which power is exercised and decisions are made. Truk lagoon islands and the Carolinian Atolls remain more egalitarian, and elected office holders seem to carry more weight than the local chiefs of limited powers who represent the traditional order.

IMPLICATIONS FOR FUTURE MANAGEMENT

The implications for resource management and development are clear. Cash and wage labor opportunities will be increasingly valued, and any attempt to lure people back to major involvement in subsistence agriculture will meet with limited success at best. Federally-sponsored programs have had a deleterious impact on agriculture and fishing, particularly in the TTPI, yet no evaluation of these programs and their impact on island societies has been made. Such an evaluation should be made before rational plans can be made for the management and development of renewable resources.

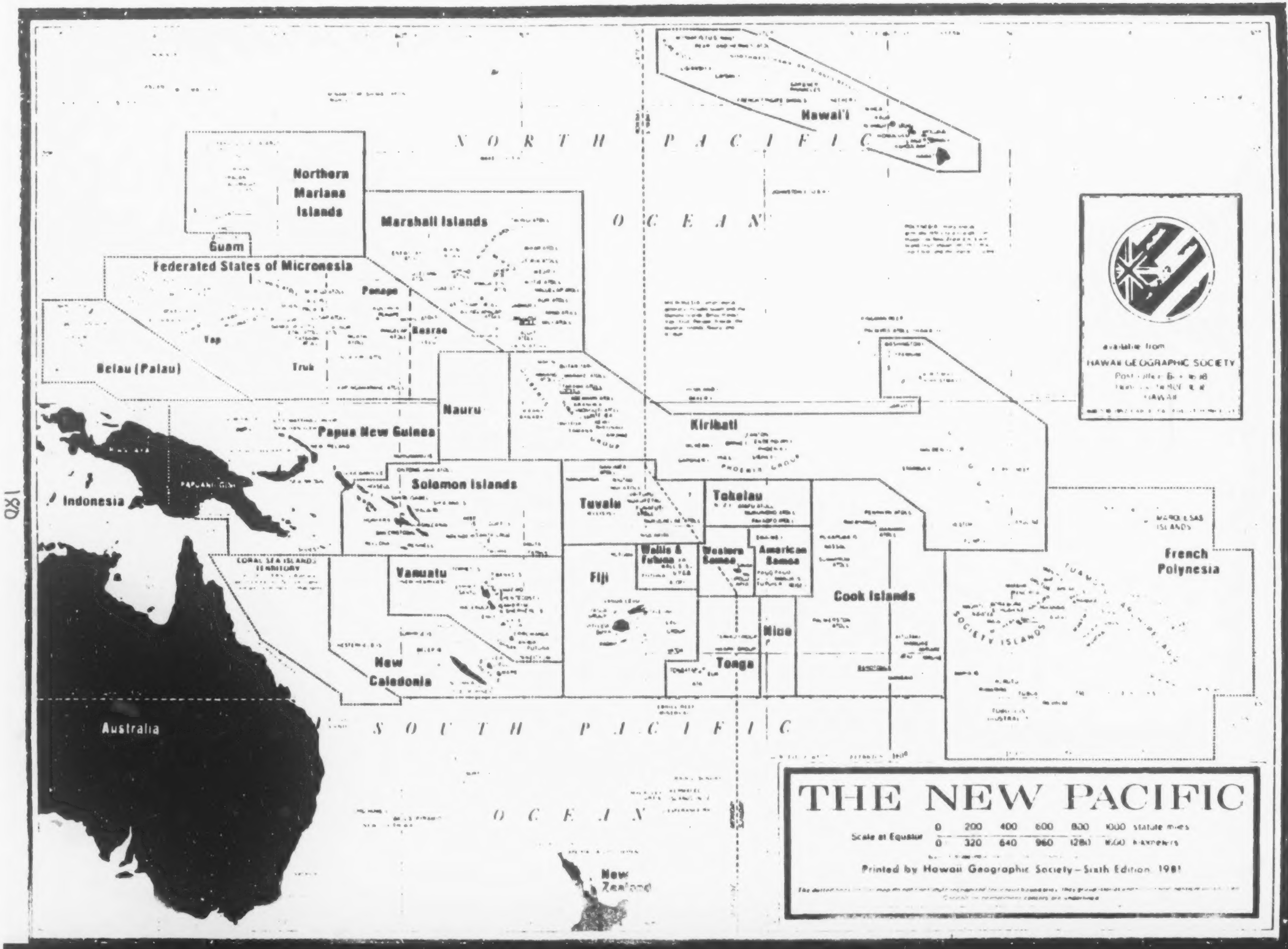
Given the increased urbanization that is occurring and the preference of many islanders for the urban environment, any realistic planning for the future and the management and development of resources will have to include urban planning. This need is being overlooked entirely in the Pacific region today; most planning schemes are aimed at improving the quality of rural life and encouraging islanders to remain or return to rural areas.

Assuming that the movement to urban areas will continue, one strategy to interest islanders in agricultural development would be to assist with marketing in those population centers. Such a strategy would necessarily involve developing adequate land and water transportation and, in some instances, air shipment. Marketing sites and schedules, cooperation with existing retailers, and regular shipping schedules would have to be created. Some training in commercial crop production would probably be required, and if such an overall scheme met the cash needs and wants of rural people, some would probably be motivated to engage in such development.

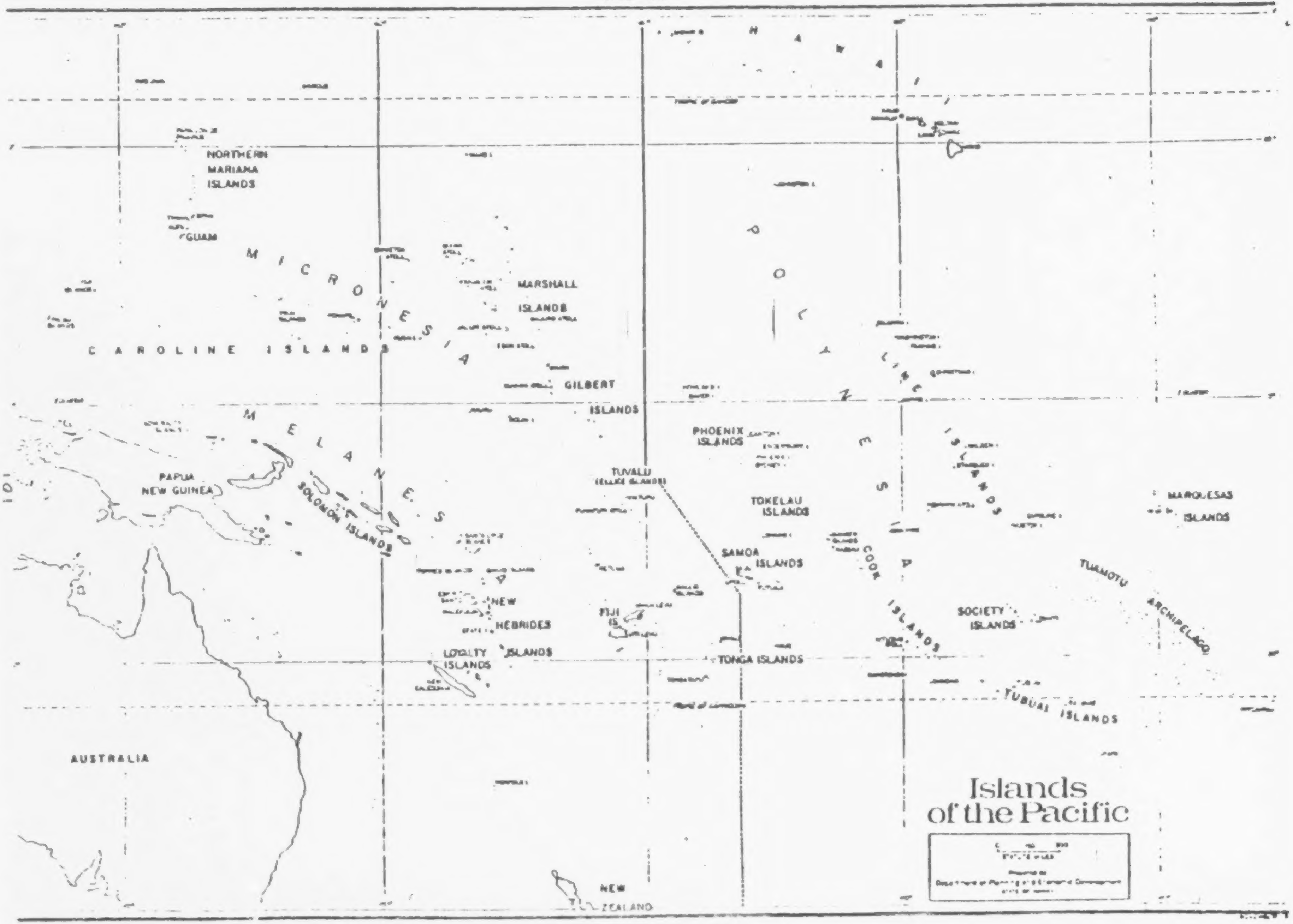
In short, there is little reason for much optimism that a concern with good management and development of renewable resources will come from the ranks of the indigenous people. At the same time, and if the past is any indication of the future, directions provided by the federal government will lack understanding of local cultures, and conditions.

In any event, a generalized plan, policy, or schema for action cannot be developed for all of the island entities except in the vaguest of terms. Each entity will require a course of action that is specific to its particularly time, place, and set of conditions. The diversity of cultures, colonial histories, and ecologies determine that this is the case.

MAP I


THE NEW PACIFIC
Scale at Equator 0 200 400 600 800 1000 statute miles
0 320 640 960 1280 1600 kilometers
Printed by Hawaii Geographic Society—Sixth Edition 1981
available from HAWAII GEOGRAPHIC SOCIETY
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
Hawai'i
Northern Mariana Islands
Guam
Marshall Islands
Federated States of Micronesia
Ponape
Kosrae
Yap
Truk
Belau (Palau)
Nauru
Kiribati
Papua New Guinea
Indonesia
Solomon Islands
Tuvalu
Tokelau
Wallis & Futuna
Western Samoa
American Samoa
Fiji
Vanuatu
New Caledonia
Niue
Tonga
Cook Islands
French Polynesia
Marquesas Islands
Society Islands
Australia
New Zealand
Coral Sea Islands Territory

MAP II


HAWAII
NORTHERN
MARIANA
ISLANDS
GUAM
MICRONESIA
CAROLINE ISLANDS
MARSHALL
ISLANDS
GILBERT
ISLANDS
POLYNESIA
LINE ISLANDS
PHOENIX
ISLANDS
TUVALU
(ELLICE ISLANDS)
TOKELAU
ISLANDS
SAMOA
ISLANDS
COOK
ISLANDS
MARQUESAS
ISLANDS
TUAMOTU
ARCHIPELAGO
SOCIETY
ISLANDS
TUBUAI ISLANDS
TONGA ISLANDS
MELANESIA
PAPUA
NEW GUINEA
SOLOMON ISLANDS
NEW
HEBRIDES
ISLANDS
FIJI
IS.
LOYALTY
ISLANDS
AUSTRALIA
NEW
ZEALAND
Islands
of the Pacific

APPENDIX A

POPULATION TRENDS

Pre-European population figures for the Pacific are extremely unreliable, and the reports of early explorers varied greatly and were no better than guesstimates. For example, the estimated population of the Mariana Islands at the time of contact ranged from 40,000 to 100,000. One observer estimated that Guam alone, the southernmost of the group, had 40,000 inhabitants (Hainline, 1970:273). It is known, however, that under Spanish colonial rule, the total population of the Marianas dropped to about 3,539 souls by 1710, and most of the people were moved to Guam to provide a convenient labor pool for the Spanish port (Thompson, 1947:34).

While the Marianas data represent a somewhat extreme case, they point to the fact that most island populations experienced considerable depopulation in the years and decades after European contact. The main killers were diseases against which the islanders had no immunity. Infirmities related to the previously unknown alcoholic drinks took their toll. Firearms increased the seriousness of warfare and probably the frequency of violent deaths. Europeans introduced two versions of the trinity—one was that of the missions, and the other was composed of disease, alcohol, and firearms.

Sometime around the turn of the century, populations in many parts of the Pacific leveled off, and began a slow recovery. This was not widely perceived, however, and the prevailing opinion as late of the 1930s was that Pacific peoples were becoming extinct, and the region would truly become a European lake. Writing as late as 1941, Felix Keesing, one of the deans of Pacific anthropology, called attention to the fact that the Pacific's populations were recovering (Keesing, 1941:43).

Historian K. R. Howe believes that recent demographic research has been of good quality, and he suggests that: "[t]he dubious habit of guessing about earlier guesses has been refined at least to the extent of being able to discard the more extreme figures." Drawing upon a variety of sources, Howe suggests that in the 1600s, the Marianas had a population of 50,000. In the mid-late 1800s he gives figures of 10,000 for the Marshalls and 25,000 for the Carolines.

The Germans were not ambitious demographers in Micronesia, and the first thorough census was not done until 1920 in the Japanese era. Table I presents census data for what is now the TTPI for 1920 and 1935 in Japanese times, and 1948, 1970, and 1983 in the American period. The figures reflect that a slight population recovery was occurring during the Japanese times (except for Yap). The data, however, report only the indigenous population and do not reflect that, by 1935, Japanese settlers in Micronesia totaled 51,861 and slightly outnumbered the Micronesians. By World War II, the Japanese were about 100,000, outnumbering the islanders by two to one.

The post-war data reflect a general Pacific-wide trend. With improved health measures, populations have been and are expanding rapidly. By the early 1980s, the TTPI population had more than tripled its 1935 number, and it is anticipated that it will at least double in the next two decades. Expanding populations and corresponding pressures on resources probably represent the greatest problem that Pacific islanders will face in the near future.

Tables II and III give the population figures for Guam and American Samoa since the turn of the century, and the same trend is apparent. On Guam, the immediate post-war population had doubled that of the turn of the century.

The extreme and unusual growth in the post-war years in part is accounted for by the fact that Guam has a sizeable military establishment as well as substantial numbers of immigrants.

For American Samoa, the resident population of the early 1980s had multiplied six times that of 1900. Table III, however, does not tell the whole story. The table reports only the indigenous population in the islands. Not evident is that there are now as many Samoans in Hawaii and the mainland (mainly California) as there are in American Samoa.

TABLE I

POPULATION OF TRUST TERRITORY

DURING JAPANESE AND AMERICAN RULE *

Year	Northern Marianas	Belau	Yap	Truk	Pohnpei	Kosrae	Marshalls	Total	Source
1920	3,398	5,754	8,338	14,738	6,638	—	9,589	48,505	#1
1935	4,297	6,230	6,006	15,129	8,953	—	9,958	50,573	#1
1948	6,071	11,839 **		14,936	9,798	—	10,802	53,446	#2
1970	13,076	12,686	7,369	29,334	21,423	—	20,166	107,054	#2
1983	19,635	13,000	10,595	44,596	26,922	6,262 ***	34,923	155,933	#2
			FSM Total = 88,375						

* Population figures do not include aliens.

** Belau and Yap were lumped together in initial U.S. Navy census.

*** Kosrae was previously included with Pohnpei.

Source #1 - Tadao Yanaihara, Pacific Islands Under Japanese Mandate, Institute of Pacific Relations, Kelly and Walsh Limited, Shanghai, 1939.

Source #2 - U.S. Department of State, Trust Territory of the Pacific Islands, Annual reports for 1949, 1971, and 1984, U.S. Government Printing Office, Washington, D. C.

TABLE II

POPULATION OF GUAM DURING AMERICAN RULE

Year	Population	Source
1901	9,630	#1
1920	13,698	#1
1940	21,502	#1
1945	22,476	#1
1950	59,498	#2
1960	67,044	#2
1970	84,996	#2
1980	105,979	#2

Source #1 - Laura Thompson, Guam and Its People, Princeton Univerity Press, 1947.

Source #2 - U.S. Department of Commerce, 1980 Census of Population. U.S. Government Printing Office, 1982.

TABLE III

POPULATION OF AMERICAN SAMOA DURING AMERICAN RULE

Year	Population	Source
1900	5,679	#1
1920	8,056	#1
1940	12,908	#1
1960	20,051	#1
1980	32,297	#2

Source #1 - Norma McArthur, Island Populations of the Pacific, University of Hawaii Press, 1961.

Source #2 - U.S. Department of Commerce, 1980 Census of Population, U.S. Government Printing Office, Washington, D. C., 1982.

FOOTNOTE

[1] Yap itself deserves special mention. Yapese society had the matriclans of elsewhere, but there was no lower order of matrilineages. Rather, each village was comprised of a number of landholding patrilineages; one simply belonged to the lineage of his or her father. The land of each patrilineage was ranked; the lineage with the highest ranking land was senior; its head was the village chief.

Additionally, village lands were ranked as high or low caste land. The high caste land was divided into five classes, and the lower caste into four. High caste villages occupied the best land, and they "owned" the land of low caste villages. The low caste performed services for their high caste lords, and the latter were obligated to look after the welfare of the former. Yapese say that their system came into being at a time when there was overpopulation and perhaps natural disaster. Some people were reportedly landless and were taken care of by what were later to become high caste villages. At any rate, Yapese were organized in a system of interlocking villages which had ties of mutual responsibility. The matriclans functioned as they did elsewhere and provided security.

ACRONYMS

ASG	American Samoan Government
CIA	Central Intelligence Agency
FSM	Federated States of Micronesia
TTPI	Trust Territory of the Pacific Islands
UN	United Nations
US	United States

BIBLIOGRAPHY

Alkire, William H. 1977	*An Introduction to the Peoples and Cultures of Micronesia*, Cummings Publishing Co., Menlo Park, California.
American Samoa Government 1981	*American Samoa 1981 Annual Report*, Office of Public Information, Pago Pago, American Samoa.
Bellwood, Peter 1979	*Man's Conquest of the Pacific*, Oxford University Press, New York.
Bryan, Edwin H. 1951	"Central and Western Polynesia," in *Geography of the Pacific* (Otis W. Freeman, Editor), John Wiley and Sons, Inc., New York and London.
Carter, John 1984	*Pacific Islands Year Book, Fifteenth Edition*, Pacific Publications, Sydney and New York.
Crawford, David and Leona 1967	*Missionary Adventures in the South Pacific*, Charles E. Tuttle Co., Rutland, Vermont and Tokyo, Japan.
Economic Research Center 1983	*Annual Economic Review and Statistical Abstract Guam 1983*, Guam Department of Commerce, Tamuning, Guam.
Fischer, John L. 1970	*The Eastern Carolines*, Human Relations Area Files Press, New Haven, Connecticut.
Furnas, J. C. 1948	*Anatomy of Paradise*, William Sloane, Associates, Inc., New York.
Goodenough, Ward H. 1955	"A Problem in Malayo-Polynesian Social Organization," in *American Anthropologist*, Vol. 57, No. 1.
Gray, J. A. C. 1960	*Amerika Samoa*, United States Naval Institute, Anapolis, Maryland.
Hainline, L. J. 1970	*Human Ecology in Micronesia*, Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles.
Heine, Carl 1974	*Micronesia at the Crossroads*, University of Hawaii Press, Honolulu.
Howe, K. R. 1984	*Where the Waves Fall*, University of Hawaii Press, Honolulu.

Johannes, R. E.
1981
Words of the Lagoon, University of California Press, Berkeley and London.

Keesing, Felix M.
1941
The South Seas in the Modern World, John Day Co., New York.

Kiste, Robert C.
1983a
"The fine print of the compacts," in *Pacific Islands Monthly*, November.

1983b
"The policies that had a non-policy," in *Pacific Islands Monthly*, October.

1984
"Overview," in *Oceania: A Regional Study* (Frederica M. Bunga and Melinda W. Cook, Editors), U.S. Government Printing Office, Washington, D.C.

Manchester, Curtis A.
1951
"The Caroline Islands," in *Geography of the Pacific* (Otis W. Freeman, Editor), John Wiley and Sons, Inc., New York and London.

Mason, Leonard
1951
"Micronesia: Marshalls, Gilberts, Ocean Island, and Nauru," in *Geography of the Pacific* (Otis W. Freeman, Editor), John Wiley and Sons, Inc., New York and London.

McArthur, Norma
1961
Island Populations of the Pacific, University of Hawaii Press, Honolulu.

Nevin, David
1977
The American Touch in Micronesia, W. W. Norton and Co., New York.

Oliver, Douglas
1951
The Pacific Islands, Harvard University Press, Cambridge.

Sahlins, Marshall D.
1971
"Differentiation by Adaptation in Polynesian Societies," in *Polynesia: Readings on a Culture Area* (Alan Howard, Editor), Chandler Publishing Co., Scranton, London, Toronto.

Thomas, William L.
1968
"The Pacific Basin: An Introduction," in *Peoples and Cultures of the Pacific* (Andrew P. Vayda, Editor), Natural History Press, Garden City, New York.

Thompson, Laura
1947
Guam and Its People, Princeton Univerisity Press, Princeton, New Jersey.

U.S. Department of Commerce
1982
1980 Census of Population, Number of Inhabitants, American Samoa, U.S. Government Printing Office, Washington, D.C.

1982
1980 Census of Population, Number of Inhabitants, Guam, U.S. Government Printing Office, Washington, D.C.

U.S. Department of Labor
1982
Various Industries in American Samoa, U.S. Government Printing Office, Washington, D.C.

U.S. Department of State
1984
Trust Territory of the Pacific Islands, 37th Annual Report, U.S. Government Printing Office, Washington, D.C.

University of Guam
1975
The Social-Economic Impact of Modern Technology Upon A Developing Insular Region, Volume IV, University of Guam, Mangilao, Guam.

Van Cleve, Ruth C.
1974
The Office of Territorial Affairs, Praeger Publishers, New York and Washington.

Yanaihara, Tadao
1939
Pacific Islands Under Japanese Mandate, Institute of Institute of Pacific Relations, Kelly and Walsh Ltd., Shanghai.

Background Paper No. 5

THE CRITICAL ROLE OF THE U.S. CONGRESS IN FOSTERING SELF-RELIANCE IN THE FREELY ASSOCIATED STATES OF MICRONESIA

by

Henry M. Schwalbenberg, S.J.
West Side Jesuit Community
New York, New York

Condensed by Susan J. Wintsch

1986

Prepared for

U.S. Congress, Office of Technology Assessment,
Integrated Renewable Resource Management for U.S. Insular Areas,
Washington D.C.: U.S. Government Printing Office, 1987.

TABLE OF CONTENTS

I. Introduction

II. Background: Micronesian Decolonization

III. The Micronesian Economies

  A. The Traditional Economy

  B. Economic Development of Micronesia Under Japan and the United States

  C. The Compact of Free Association

IV. Congressional Recommendations

Appendix

Footnotes

Bibliography

Tables and Figures

I. INTRODUCTION

With the impending end of the Trusteeship and entrance into a Free Association relationship, Micronesia and the United States will, over the next 15 years, face new challenges. The U.S. will have an opportunity to modify its past economic approach to the islands. Over the course of this decade, the U.S. Congress will play a critical role in either fostering Micronesian self-reliance or perpetuating the overwhelming economic dependency of these islands on the United States. Attaining some level of self-reliance will not only be beneficial in the long run to the Micronesians, but will also protect major U.S. interests in the area: namely, the protection of human rights and the maintenance of peace in the central Pacific.

Attaining any increased level of Micronesian economic self-reliance is closely related to the problem of renewable resource management. This paper will argue that economic policies such as the expansion of exports and the encouragement of foreign investment are useful means to assist in achieving a greater degree of self-reliance. However, such economic activities can not be successfully implemented given Micronesia's limited and fragile resource base without the judicious management of all ot its renewable resources--marine, agricultural, and human.

During the Trusteeship period, generous U.S. assistance has created large (for Micronesia) government bureaucracies that provide the bulk of all jobs and incomes (U.S. Department of State, 1981). With little development of a commercial economy, and a gradual breakdown of subsistence economies, the last twenty years has seen increasing economic and political power concentrated in the government sector. In essence, Micronesia has become a state-run welfare society. The development of an independent private economy based on the sustainable development and exploitation of local resources can counter this trend. By providing an economic foundation for a pluralistic society, the U.S. can significantly contribute to the protection of human rights and democratic ideals in these island states.

The development of a more self-reliant economy will also serve U.S. security interests in the area. Micronesia played a strategic role in the Pacific War, and the area has potential strategic importance in the event of war as an alternate trade route to U.S. Asian and Pacific allies (one outside the range of Soviet land-based aircraft).[1]

The Compact of Free Association is often seen as a quid pro quo arrangement between the United States and Micronesia, whereby the Americans give money to the Micronesians in exchange for military rights in the area (Congressional Record, July 25, 1985). This view over the long run can have detrimental effects on the stability and security of the region. If Micronesians continue to equate roughly 90 percent of their financial wealth with the U.S. military presence, they will continue, as a proven negotiating tactic, to challenge directly or indirectly, U.S. military prerogatives in the region in order to extract higher military rental payments.[2] In this manner overwhelming economic dependency has led to tensions in U.S.-Micronesian relationships.

Were Micronesia made less dependent on the United States through the expansion of Micronesian exports into U.S. and other markets and through increased American and other foreign private investment, a larger indigenous business elite would emerge whose self interest would tend to support and encourage those U.S. security agreements that provide stability for the area and incentive for foreign investment and trade.

Over the next 15 years as the United States and Micronesia enter into a new political relationship, the U.S. Congress can begin to redirect U.S. economic policy and foster a more self-reliant Micronesia better equipped to become a dependable partner with the United States in protecting human rights and regional security.

II. BACKGROUND: MICRONESIAN DECOLONIZATION

The Micronesian islands, once part of the Japanese Empire, were captured by American soldiers after fierce fighting during the Pacific War. Since the Atlantic Charter forbade the annexation of territory gained through war, the United States never claimed sovereignty over the islands (Stone, 1945). In

---

[1] Analysis of the military importance of Micronesia can be found in John Dorrance, "United States Security Interests in the Pacific Islands," February 1984, reprinted in Hearing on National Security Implications of the Compact of Free Association, before the Subcommittee on Public Lands and National Parks, 98th Cong., 2d Sess., August 7 and 9, 1984, 203-223; John Dorrance, Micronesian Crosscurrents and the U.S. Role in the Western Pacific, The National War College, Washington, D.C., 20319, 1975; and Henry M. Schwalbenberg, S.J., "American Military Needs in Micronesia: Valid Perceptions or Unnecessary Contingencies?" Memoranda on the Compact of Free Association, Truk, Caroline Islands: Micronesian Seminar, October 1982.

[2] See Arthur John Armstrong and Howard Loomis Hills, "The Negotiations for the Future Political Status of Micronesia," American Journal of International Law, Vol. 78, No. 2, April 1984; and Henry M. Schwalbenberg, S.J., "FSM and Denial," Pacific, March/April 1983.

accordance with an agreement with the United Nations Security Council, it has administered the area as a United Nations Strategic Trusteeship. The U.S. was given plenary control over the islands, including the right to establish military bases and foreclose access, but was also charged with protecting the welfare of the inhabitants and with preparing the islands for eventual self-government or independence (U.S. Department of State; 1984).

This study deals only with the Marshall and Caroline archipelagos, which have a total population of roughly 136,000 people, and are fragmented into three island countries: the Republic of the Marshalls, the Republic of Palau and the Federated States of Micronesia. The latter include the Kosrae, Pohnpei, Truk and Yap islands groups. In 1983, all three island countries voted by majorities in UN-observed referendums in favor of a new political status called Free Association (United Nations Trusteeship Council, T/1865, 1984; T/1860, 1984; T/1851, 1983). Palau's Constitution, however, requires a 75 percent majority to vote in certain military arrangements (with the United States) that form a basic component of the Free Association package. Since this was not achieved, the future political status of Palau remains unresolved. The Free Association compacts with the Marshalls and the Federated States are presently awaiting approval by the U.S. Congress.

Free Association is essentially a compromise between independence and political incorporation into the United States that recognizes the sovereignty of the Micronesian people and would replace the UN Trusteeship with a system of self government. The United States would continue to have full authority and responsibility for all military matters. The Micronesian governments pledge to refrain from any action that the U.S. determines to be incompatible with U.S. military authority in the area; should Micronesians eventually decide to become independent, they could not terminate the U.S. right to foreclose military access to the area without U.S. consent. Finally, the Micronesians would receive grants from the U.S. to fund government operations, social services, development projects, and an array of tax and trade benefits to encourage local economic development (Office of Micronesian Status Negotiations, 1983).

To understand how Free Association will affect Micronesia, how U.S. economic policy should be directed under it, and whether Micronesia can achieve economic self-reliance through the sustainable development of its renewable resources, it is necessary to understand the nature of Micronesian economies.

III. THE MICRONESIAN ECONOMIES

Living standards in Micronesia, although substantially lower than in U.S. territories, are among the highest in the Pacific, and far above those in other developing countries in Southeast Asia (Table 1). Although local resources are among the poorest in Asia and the Pacific, the islands have developed affluent service economies with the support of the U.S. Treasury (United Nations Economic and Social Survey of Asia and the Pacific 1984, 1985).

At present, Micronesia's cash economy (as distinct from its subsistence economy) is roughly 90 percent dependent on U.S. financial assistance.[3] Almost all wage employment is generated directly or indirectly by the government welfare bureaucracy. Micronesia's cash economy is concentrated in seven Micronesian towns--Majuro, Ebeye, Lelu, Kolonia, Moen, Colonia, and Koror--and there is a large income gap between town and rural populations. For the past 20 years, and with rapid increases in U.S. assistance, there has been a steady migration into the seven main towns (Table 5, Figure 2). This has only recently begun to abate as U.S. grants have leveled off (Table 11). There has also been a large exodus from the Palauan Islands to the United States and U.S. territories, principally Guam (Schwalbenberg, 1984d).

Given the extensive U.S. aid and the scarcity of natural resources, there is little incentive for productive enterprise in Micronesia. Local commercial agriculture and industry are almost nonexistent. Other economic problems stem from internal and external migration and an increasingly unequal distribution of income.

A. THE TRADITIONAL ECONOMY

Micronesia's cash and subsistence economies sometimes conflict; at other times they are mutually supportive. In studying traditional economic systems, the economist enters a world without prices, wages or profits. Western assumptions and methods of analysis become inappropriate. In the absence of prices, it is impossible to quantify many economic measures or to easily assess the relative value of labor and goods.[4]

---

[3] See the development plans of either the Federated States or the Marshall Islands for a national income accounting breakdown.

[4] A new approach is called for. Marshall Sahlins of the University of Chicago and E. K. Fisk of the Australian National University are perhaps the foremost students of the traditional economies among Pacific islands. In large part the following discussion of the traditional Micronesian economy is an oversimplified summary of their work.

In general, the subsistence economy of Micronesians includes a production sector controlled and organized to serve individual family needs; an exchange sector governed by kinship and tribal political organization to serve wider community needs; and an investment sector governed by nature. The production and distribution of goods are not determined by wages, prices, and profits in the normal sense, but by such nonquantifiable factors as the satisfaction of fulfilling kinship and other traditional responsibilities, the status and recognition this brings, and the inconvenience that work entails.

The Production Sector

The family's ability to provide labor, and its access to needed resources and simple technologies, gives it basic control over the traditional economy. The family unit decides which goods to produce and what labor to allocate to satisfy its needs, and is thus the basic unit of production as well as of consumption.

In traditional Micronesian society, labor is divided into men's and women's work. Together these provide most of the society's needed goods, and they also describe the basic labor resource of the family. A single family is capable of fashioning and controlling the basically simple means of traditional production. Finally, in traditional societies families have usufructuary privileges to the land and sea and can decide how to use and dispose of their shares of these resources. Ownership is invested in lineages and clans; each member family is guaranteed access to the needed raw materials.

Household protection in traditional Pacific societies is highly productive and tends to underutilize available resources. E. K. Fisk has called this "subsistence affluence," and maintains that families can produce all they need of the basic staples, clothing and housing with, on average, no more (and sometimes less) than three or four male labor hours a day.[5] Production ceases when family needs are met.

The Exchange Sector

Obviously overproduction is not a problem in traditional economies as it often is in the industrialized world where profit and production maximization are basic goals. In fact, the traditional Pacific island economy underproduces, a dangerous tendency given the fact that the relatively small labor force of a single family can easily be beset by overwhelming difficulties. Individual families may have more unproductive dependents than productive workers, or suffer incapacitating disease or injury. Bad luck or lack of skill can also translate into a food shortage. An autonomous family simply cannot be completely self-reliant.

---

[5] Fisk, 1982, p. 10.

Family-based production is not organized for sustained yield even in normal times. Rather, it is directed toward the supply of a customary stock of consumables, and once family needs are met, there is no longer any incentive to produce.[6]

Vulnerability to outside forces and failure to produce surpluses are counteracted by the exchange sector, institutionalized in the form of kinship and chieftainship. This sector acts to organize collective work such as community construction projects, assistance to less productive families, and warfare. Kinship responsibilities force effective producers to produce a surplus for distribution to needy relatives and to poorer households along kinship lines.

Chieftainship, or the organization of authority in traditional society, also tends to offset the inherent limits of family production by bridging kinship lines. The chief, responsible for the entire community's welfare, is empowered at times to force households to raise labor and production levels to benefit the entire community.

The Investment Sector

Since the rare surpluses from household production are usually directed to needy households, it would appear that nothing can be saved and invested in future economic development. In one sense this is correct. The Micronesian traditional economy does not grow. As Fisk argues, the affluent subsistence economy is essentially stagnant. Total production and consumption may grow with the population, but per capita production remains virtually constant for long periods.[7]

Although there is nothing comparable to the economic surplus produced as in industrial economies, there is investment in another sense, in what is left fallow. When land plots and fishing areas are unused for long periods, nature itself is able to replenish those resources, depending on degree and length of exploitation. Without such "recharges" it would be impossible to absorb the shocks created by sudden population movements. Typhoons, which necessitate such movements, are not uncommon in many of the outer islands of Truk and Yap.

Through underproduction and kinship exchanges then, Micronesia's traditional economy has successfully sustained itself in an environment that often has strict resource limitations.

---

[6] Sahlins, 1971.

[7] Fisk, 1982, p. 9.

Changes Brought by Western Contact

Thanks in large part to the affluent subsistence economy and to low population pressures and consumer demands, severe poverty does not yet exist in Micronesia (Department of State, 1948-1984). In the 1700s when Micronesia developed substantial contact with the outside world, these conditions began to change.

Population increases are particularly worrisome given the fixed limits on natural resources on a Pacific island and the need for fallow periods for resource recovery. If the population pressure is severe enough, as seems to be the case in Eauripik in the Yap outer islands, migration to less densely populated islands begins, by necessity, to occur.

Initially, western contact, through the introduction of diseases, reduced Micronesian populations (Figure 1 and Table 3). But Micronesian populations have been expanding since the late 1800s (Figure 1 and Table 4). Since the Second World War, under American tutelage and largesse, population growth rates in Micronesia have been among the highest in the world. American aid has enabled many Micronesian islands to support populations well beyond their natural capacity. Obvious examples are Kwajalein, Majuro, the lagoon islands of Truk, and Koror (Table 2).

In the absence of outside contact and trade, consumer demands are limited. Most food staples in the traditional economy are perishable and difficult to store, and the range of available goods is small. With the advent of western contact, however, access to the more sophisticated cash economies occurred. Consumer needs and desires grew, first for cloth, tools, guns, and alcohol (in the 1700s and 1800s), and now, with increasing urbanization (Figure 2, Table 5), for schools, hospitals, stereos, and cars (Hezel, 1983; Hezel, 1982c). The high level of American financial assistance has allowed consumption to rise beyond what a traditional economy could ever supply. Subsistence affluence exists today only where population pressures on resources are low, and where contact with the world economy is restricted.[8]

Western contact makes possible the transition from a subsistence to a cash economy. Unfortunately, while Pacific islanders commonly are highly productive in the traditional economy, they are usually far less so in the transition to a money economy (Fisk, 1982). Also, given the high wages of

---

[8] Fisk, 1982, p. 11.

U.S.-financed government jobs, it is difficult to attract skilled Micronesians to lower paying commercial jobs. Only where wages are high (as at the Kwajalein Missile Range), have Micronesians responded. As a result of both factors, Micronesians can be unattractive employees in a competitive world.

Throughout Micronesia's history, it has been common to import laborers (Table 6). During the Japanese period, Okinawans manned Micronesia's fishing fleets. Today, Filipinos provide most of the skilled labor for Micronesia's commercial business (Schwalbenberg, 1984d).

Micronesian employment at low wages is not unheard of, but it is usually a short-term undertaking to obtain a certain amount of cash for a particular item. Most employers prefer long-term workers who can be relied upon and who have time to develop the necessary experience and skills to improve their productivity. To get these workers at low wages, employers often seek immigrant labor.

The Aftermath

Can Micronesians return to the subsistence affluence now that they have tasted the fruit of modernization? The answer seems to be an emphatic no. Not only is the traditional economy stagnant; many Micronesians have lost the skills needed to function in it. Only the dynamic money economy (along with some financial assistance) can meet the rising expectations of expanding Micronesian populations.[9] Fisk (1982) argues that surplus human and natural resources (those left fallow) in a traditional economy could be used to develop a productive money economy without inflicting substantial economic hardship. It was through the use of such unemployed resources, along with financial incentives and assistance, that the Japanese were able to commercially develop these islands in the 1930s.

B. THE ECONOMIC DEVELOPMENT OF MICRONESIA UNDER JAPAN AND THE UNITED STATES

Little research has been done on Micronesian economic history. It was the privilege of this writer to have the opportunity to prod Father Francis X. Hezel, S.J., the present director of the Micronesian Seminar in Truk and perhaps the most published historian on Micronesia, to summarize the economic history of the islands in writing. With Father Hezel's permission, portions of his summary that deal with the period of Japanese and American administration of the islands are excerpted below.[10] It should be noted that when Father Hezel discusses Micronesia during the Japanese Mandate period and during the early years of the U.S. Trusteeship, he includes the Northern Mariana Islands as well as the Caroline and Marshall Islands.

---

[9] Fairbairn and Tisdell, no date.

[10] Hezel, "A Brief Economic History of Micronesia," 1984.

1. Japanese Mandate

Buildup of Japanese Firms: NKK and NBK

Shortly after the Japanese seizure of the islands in 1914, several Japanese entrepreneurs unsuccessfully attempted to grow sugar in Saipan. In 1921, Matsue Shunji visited Micronesia to explore the possibility of a sugar industry in the islands and, after some difficulty, managed to persuade Japanese investors to underwrite a new company. The company was begun in 1921 with capital of three million yen and Matsue as its director. It was named Nanyo Kohatsu Kabushiki Kaisha, or simply Nanyo Kohatsu Kaisha (NKK). In the same year, the company began operations on Saipan, and in the following year a sugar mill was set up there. Later operations were expanded to Tinian, Rota and Pohnpei. The business prospered, and by 1934 NKK had 20,000 acres under cultivation.

Nanyo Kohatsu Kaisha also took over the phosphate mining activities in Micronesia. The Anguar mines were put under the jurisdiction of the Japanese military following the seizure of the islands from Germany. In 1922, the Japanese government finally purchased all mining rights and equipment in the western Carolines. Sometime after this, NKK obtained mining rights in Anguar and eventually in Babeldaob and Fais as well.

In addition to a monopoly on sugar production and phosphate mining, NKK also began commercial fishing operations, the production of marine products, and the cultivation of crops associated with the production of starch, hemp, cotton and other crops. The company had 8,000 employees, almost all of them Japanese nationals, and was responsible for 9,000 dependents by the mid-1930s. NKK was the largest company in the islands and ruled commerce in the Mandate together with the Nanyo Boeki Kaisha.

The Nanyo Boeki Kaisha (NBK), whose pedigree could be traced back to Spanish times, complemented the business activities of NKK. The origins of NBK lay in the early trading companies that pioneered Japanese trade in Micronesia in the 1890s. When the most successful of these early firms, Nanyo Boeki Hioki Goshi Kaisha, merged with another later arrival in 1906, NBK was born. For almost a decade before the Japanese occupation of Micronesia, it was the dominant Japanese trading interest in the islands.

NBK prospered under the Japanese Mandate. It controlled all the copra trade and did some business in fish and marine products, besides running a string of 32 retail stores throughout the islands that employed some 700 Micronesians. NBK also controlled the freight and transportation through the islands. NBK and NKK both received government subsidies, and between them they had 50,000 acres under cultivation (about one-third of all the arable land in Micronesia) (Yanaihara, 1940; U.S. Department of Navy, 1943-1944; Purcell, 1967).

Early Development Period

The period of early Japanese rule (1914-1922) was one of administrative experimentation. The main concern of the government during these years was to find an administrative structure that worked well; meanwhile, many of the old German policies were continued. Mining operations on Anguar were carried on, and the old tax system imposed by the Germans was adopted almost intact by the Japanese. The military government of the islands was recognized as a temporary one, and so there was no attempt made to develop long-range economic policies for the islands.

With the establishment of the civilian government over the islands in 1922, economic development began in earnest. It was at this time that the sugar industry, which was to become the mainstay of the island economy under the Japanese, began in Saipan. From the very outset, Japanese nationals were brought in to cultivate and harvest the sugar, since the islanders did not seem to like the arduous work. NKK, with the help of a government subsidy, provided transportation for the Japanese or Okinawan (and his family), land for cultivation, and a loan for the purchase of supplies that he might need. In turn, he was to sell all his sugar to NKK according to the terms of a contract.

Sugar Industry

With the help of liberal government subsidies (amounting to about half a million yen each year by 1930), the sugar industry flourished in the Marianas. It soon diversified and began producing molasses and alcohol. By 1936, 13 million yen worth of sugar was being exported yearly, with another million coming from exports of alcohol (Table 7). Hence, 14 million out of the total export value of 25 million yen was from sugar. In the years prior to 1936, sugar accounted for an even higher percentage of the total exports: it brought in 14.4 of 18.4 million yen, or 79 percent of all export income, in 1934; and 20.4 of 26.4 million yen, or 77 percent of the total, in 1935. Sugar, then, was the backbone of the economy during the 1930s.

The government worked extremely closely with the NKK-run sugar industry, providing subsidies, setting prices for the purchase of sugar, and providing land for the industry's expansion. So close was this collaboration as the sugar industry began to bloom that one could say that this industry's needs determined government policy in the Mandate, even when this necessitated an abrupt change in direction. This is illustrated best in the case of land and immigration policies in the islands.

Immigration and Land Policies

Initially, the Japanese government did not seem to favor heavy immigration into the islands, just as it did not approve of displacement of native populations within the islands. In fact, the government returned the Ponape exiles who had been sent to Palau after the Sokehs rebellion. In 1920, there were only 3,600 Japanese living in Micronesia. As the sugar industry (and some of the other industries also) required more labor, massive immigration from Japan occurred. In 1930 there were 20,000 Japanese nationals living in the islands; by 1935 there were over 50,000; and by 1940 there were about 85,000. Eighty percent of the total labor force in the islands was Japanese or Okinawan. Such large-scale immigration from abroad meant that the government had to provide social services for these foreigners, a task that increasingly absorbed the attention of the administration through the 1930s.

Sugar production, and to a lesser extent other agricultural projects, demanded an ever greater amount of land. In 1925 there were about 7,000 acres planted in sugar (Table 7). In 1930 the acreage had grown to 15,000; by 1935 it was nearly 25,000; and in 1940 it was about 40,000. The demand for land for sugar and other crops necessitated changes in the Japanese government's land policy. At first the Japanese administration claimed the title to all land held by chiefs by virtue of their traditional powers, but it discouraged the sale by Micronesians of private land. The survey of land holdings conducted in 1932 revealed that the Japanese government had title to 156,000 acres, compared with 60,000 under private ownership of Micronesians. Much of the government land was leased to NBK and NKK for production and industry. As land needs continued to grow during the early 1930s, the government conducted a survey of all private lands. Finally, in order to accommodate the increasing number of immigrants, the government began to buy and lease private land. Eventually, therefore, the administration reversed its original land policy in the islands.

Other Major Industries

Another product exported by the Japanese was phosphate. When the Japanese took over the Anguar mines during World War I, they continued the mining operations much as the Germans had. The rate of production during most of the Japanese administration was between 60,000 and 90,000 tons a year, about the same as it was during the last years of German rule. During the late '30s, however, output doubled to between 120,000 and 200,000 tons. The Japanese, like the Germans, employed Micronesian laborers in the mine--and this was the major source of wage employment for Micronesians during this period. The number of native laborers under the Japanese averaged about 360 a year, fewer than the number that the Germans employed since the Japanese employed 100 or so of their own people each year. Laborers were required to work six days a week and received wages of about 13 yen a month in addition to food and lodging.

Copra remained a steady source of money for the islands, even though it was eclipsed by sugar during Japanese times as it had been by phosphate during German times. It also was one of the few means that islanders had of earning money, since most jobs in the agricultural and fishing industries were held by Japanese. Some 10,000 islanders made copra and sold it to local representatives of NBK and other trading concerns. In 1936 the export of copra was valued at slightly more than two million yen. The Japanese government encouraged the copra industry by offering subsidies for planting palms and for the erection of drying sheds. As a result, copra production doubled from 13 million pounds yearly at the end of German rule to 26 million pounds during the mid-1930s.

Marine products constituted the fourth major commercial industry under the Japanese. During German times activities had been restricted to those few goods (beche-de-mar, shark fin and shell) that could be sold to the China market, and the income remained insigificant when compared with copra and phosphate. The Japanese government, however, made a deliberate effort to exploit the potential of maritime industries. First they made a scientific survey of all marine products throughout the islands and established an experimentation center in Palau (Yanaihara, 1940; Japanese Government, 1926-1937). In addition, they subsidized the fishing industry, as they had other industries. As a result, the islands soon produced many different marine products. The centers of this industry were Palau, Saipan, Truk and Ponape. The most important product was katsuobushi, or dried bonito, which produced 2.7 million yen in 1936. The export value of katsuobushi more than tripled as it reached 8.7 million yen in 1940. Besides this, the islands produced trochus shell, turtle shell, cultivated pearls, sponges, canned fish, and tropical fish. In all, perhaps 4 million yen was earned from exports of marine products in 1936. As in the case of the sugar industry, however, this industry was worked entirely by Japanese and Okinawans. Micronesians who collected and sold turtle shell to Japanese companies obtained some financial benefit from this.

The government also initiated experimentation with agricultural crops through its research centers on Pohnpei and Palau. The most notable aspect of this industry was the production of starch on Pohnpei from tapioca, arrowroot and sweet potatoes. Coffee was grown on Saipan in the late '20s until sugar proved more profitable. Various kinds of fruits and vegetables were introduced by Japanese agriculturalists. Cotton, sisal hemp and coconut leaves were utilized to produce fibers. Some charcoal was made, and different types of trees were introduced in the hope of producing a healthy lumber industry. Again the Japanese government furnished liberal subsidies to encourage the development of agriculture. It provided free seeds, sold farming tools at half their cost, and agreed to buy any produce at a set rate. Nonetheless, agriculture never yielded any significant financial return for the islands. The export value of all agricultural produce (with the exception of sugar) for 1935 amounted to slightly more than one million yen.

Japanese commercial activity in the Mandate was primarily concentrated in the Marianas. There was, however, substantial economic activity in Palau, Truk, and Ponape. During the 1930s, Micronesian production levels grew rapidly to a high point in 1937, when total value of exports exceeded 37 million yen. Furthermore, an increasing number of the islands were beginning to share in this economic development. A breakdown of exports by island group (as presented in Figure 3, Table 8 and Appendix A) offers a more detailed look at the Japanese achievement while providing an inventory of the main items produced.

Government Finances

The budget during the Japanese administration of the islands, although much higher than that during German times, was remarkably steady throughout the 15-year period from 1920 to the mid-1930s. Yearly expenditures averaged about five or six million yen during these years, with no marked tendency towards increasing budgets. It is significant that of the 5.4 million yen spent by the government in 1935, nearly 25 percent, or 1.3 million, went for subsidies to industries (see Table 9 for figures in 1936).

At first the Japanese Imperial Treasury supplied almost the entire administrative costs for the Mandate, but by 1933 the islands were completely self-supporting, and by 1936 they were producing a surplus revenue of one million yen annually. Of the 6.5 million yen revenue raised by the government in 1936, 60 percent came from harbor clearance fees (an export tax on sugar). Another 1.7 million yen came from duties on phosphate. The remainder of the revenue derived from custom duties and a poll tax, which was levied on all persons over the age of 16 and was very similar to that imposed by the Germans.

This period represents the height of commercial development in the islands. Never before or since have the islands of Micronesia been fully self-supporting under colonial rule (compare Figures 4 and 5). The government achieved this by encouraging productivity through (1) land grants, (2) price supports and tariff benefits, (3) subsidies, (4) immigration, and (5) education in agricultural techniques and research for new crops. But this accomplishment was purchased at a cost: immigration of Japanese to the islands on a vast scale, the alienation of large tracts of land from Micronesians, and the virtual exclusion of Micronesians from the most important commercial enterprises. Whatever economic benefits Micronesians derived from the economic success under the Japanese were entirely incidental.

United States Trusteeship

Naval Period

When Micronesia passed over into American hands at the end of World War II, the U.S. Navy assumed the responsibility of administering the islands until civilian rule could be established. From the outset, American military policy was a reaction to perceived abuses of Japanese development policy, including indiscriminate explotation of resources and the establishment, for the profit of aliens, of enterprises which do not permit the islanders to enjoy the full benefits of their own labor.[11] This was the rationale for the slow-paced approach to development through the first 15 years of American rule.

The U.S. military made two decisions that would eliminate the possibility of large-scale development. First, all Japanese were repatriated by the end of 1946, thus depriving the islands of the skills needed to restore the economy. Second, large development projects backed by foreign money were to be excluded from the islands on the grounds that they did not promote the welfare of the Micronesian people.

---

[11] Hezel and Berg, pp. 495-496.

Within a few months of the inauguration of U.S. naval administration, the United States Commercial Company (USCC) was created to supervise economic development in the island territory. This government-funded organization set about trying to rebuild the copra industry, and to restore fishing and agriculture disrupted by the war. USCC bought produce from the islanders for export and offered them, in turn, a selection of import items for purchase. In 1946, it conducted an economic survey of the territory as an aid to developing Micronesia's potential (Oliver, 1947).

In late 1947, USCC was replaced by the Island Trading Company (ITC), a corporation capitalized by the Navy and run by the Deputy High Commissioner. Its purpose was to promote development by furnishing technical assistance and services to locally-owned businesses. ITC purchased and marketed copra, handicraft and other exports; provided loans and subsidies to island businessmen; and imported goods and sold them wholesale to local stores (as USCC had done). With the assistance of ITC importing and warehousing services, retail stores proliferated quickly. By mid-1951 there were 325 such stores in Micronesia, all locally owned and many of them headed by men who would be prosperous entrepreneurs years later. ITC's attempts to encourage production of new crops for local consumption and export were unsuccessful, however. The loans that it provided for such projects as poultry, coffee, remie, coir fiber and cacao were unproductive, and the projects failed one after another.

Exports during these early years totaled about $2 million annually. Phosphate, which was close to being exhausted, accounted for more than half of that; copra brought in another $700,000. Handicraft, trochus and a few lesser items together generated $150,000. This demonstrated how difficult it was to stimulate the productive sector of the economy with retail stores.

ITC was finally liquidated in 1954, three years after civilian administration began in Micronesia under the Interior Department. By this time, local import companies such as Truk Trading Company, KITCO, MIECO and others were strong enough to survive on their own. Copra exports and shipping were contracted to a private firm, Atkins-Kroll, while the responsibility of providing loans and technical advice was taken on by the new civilian administration.

Go-Slow Development

U.S. economic policy in Micronesia from 1951-1962 was aimed at promoting eventual self-sufficiency of the territory, a possibility that seemed real, given the impressive record of Japanese accomplishments in the islands during the 1930s. The U.S. wanted to duplicate this record without the exploitation and alienation of land that had occurred under the Japanese. Hence, private capital investment was discouraged and government investment encouraged. Development was to be paced to the desires and capacity of the local people, respect was to be paid to their fondness for traditional patterns of life, and wages were to be kept consistent with the productivity of the economy. Government subsidies, especially in the social services, were carefully controlled so as not to undermine the goal of self-reliance. The annual U.S. subsidy remained at a level of $5 million or $6 million each year, barely enough to maintain necessary services. Exports generated between $2 million and $3 million each year, with copra accounting for most of this figure (Table 11 and Figure 5). A processing tax on copra, and taxes on cigarettes and luxury items, brought in merely a few thousand dollars each year. Total tax revenues throughout the territory amounted to only $200,000 out of a budget of $6 million.

Municipalities were encouraged to develop a head-tax and to use the free labor to complete local self-improvement projects. Moreover, the municipalities were assigned the responsibility of repairing their schools and paying the salaries of their teachers.

Heavy Investment in Social Services

A complete change of direction occurred in 1963. Export values had plateaued about $2 million per year, and after several experimental crops failed, the economy appeared to be stagnating. The U.S. administration, therefore, set about a program of intensive development in Micronesia. The annual appropriations for the Trust Territory doubled in 1964 to $13 million and escalated to over $60 million in 1971. Thereafter, U.S. funds continued to increase until the close of the 1970s.

Most of these funds were funneled into administration, schools and health services in the belief that a healthy, educated populace was a prerequisite for long-range economic development. Between 40 and 45 percent of the government's annual budget was allocated for health and education. During the 1950s this figure was between 16 and 18 percent (Table 12).

With increased U.S. assistance, the Trust Territory government began to assume many of the responsibilities that had once been handled by the municipalities. An increasing number of Micronesians came to depend on government salaries for their livelihoods. The local government work force rose from 2,700 in 1961 to 7,200 in 1970 (U.S. Department of State, 1960-1971). Service industries in the private sector expanded accordingly, as restaurants, bars, retail stores and movie theaters multiplied (Table 13). Total salaries for Micronesians (FSM, Belau, and Marshalls) in both public and private sectors escalated from $2.1 million in 1961 to $15.3 million in 1970 (Table 14). The imported goods that were to serve as an incentive for increased productivity became available in unprecedented quantities through the government salaries that Micronesians were earning. While the value of imports remained at about $4 million a year throughout the late 1950s, in 1970 $20 million in imports came to Micronesia (Table 11).

Exports, on the other hand, remained at earlier levels--about $3 million annually--with some minor fluctuations due largely to changes in the price of copra (Table 11 and Figure 5). Copra production remained fairly steady, despite these fluctuations (about 26 million pounds per year). The only economic project of any consequence (outside of the Marianas) was the establishment of a Van Camp fishing operation in Palau in 1964. But the impact of this on the local economy was limited to the salaries of the 50 shoreside Palauan laborers and to the local purchases made by the company, all told about $200,000 a year.

Large Supplement: Capital Improvements and Federal Programs

With its original economic development policies discarded, U.S. financial assistance continued to grow year by year. From 1970 on, expenditures on Capital Improvement Projects (CIPs) began to appear as a considerable budget item (Table 15). Much of this went (with the firm backing of Micronesian leaders) into infrastructure thought to be needed for economic development and before the island were entrusted with self-government. Between 1970 and 1979, a total of over $250 million in CIP funds was allocated by the U.S. (Table 16) for public buildings, roads, airports, and dock facilities. The CIP projects have had a considerable economic impact on Micronesia in terms of worker salaries, but it appears that their net effect on productivity is minimal. The one exception may be the benefits of airfields and roads for tourism.

During the 1970s, Federal Program grants provided another significant source of funds for Micronesia over and above the ordinary yearly subsidy. From 1974 to 1979, the Trust Territory received about $120 million in such funds, an average of $20 million a year (Table 15). Most of these were aimed at improving the social services. Still more government employees were hired. By 1979, of 19,000 Micronesians employed in Palau, the Marshalls, and the

Federated States, 11,000 were government workers. Imports continued to rise proportionately with government salaries, and in 1979 they reached a value of $38 million, for the three island states.

Total U.S. assistance, in the form of government operations, CIP money, and Federal Program funds, rose from $67 million in 1971 to $138 million in 1979 (Table 15).

Gains

Exports increased notably during this period, and for the first time in the entire U.S. administration. By the end of the decade, export values reached about $16 million yearly (Table 11 and Figure 5). Tuna exports, which amounted to slightly more than $4 million, were almost entirely the result of the Van Camp fishing operation in Palau. The sale of coconut oil and copra cake was made possible by the construction of two copra mills, one in Palau which began operations in 1977 and another in Majuro that opened in 1978. The products of these two mills accounted for sales of between $5 million and $6 million yearly. The sale of unprocessed copra throughout Palau, the Marshalls, and the Federated States brought in another $3 million. Tourism, often called the "invisible export," grew steadily through the 1970s, and by 1979 was bringing in over $2 million yearly (Table 17), besides boosting handicraft sales to about $800,000 annually.

Some of these gains were short-lived, however. The Van Camp plant in Palau closed down in 1982, and it is believed that the export of fish is once again a very minor industry, although accurate data is hard to obtain. The copra mill in Palau also ceased operations two years ago. The mill in Majuro continues producing about $2 million annually in sales of oil and cake. Tourism remains the hope of the future for many, and repeated attempts have been made to promote tourism in Micronesia. In the past year, new hotels have opened in both Palau and in the Marshalls. With $2 million from tourism, another estimated $3 million from copra exports, and perhaps $1 million from handicraft, the total exports of Palau, the Marshalls and the Federated States would probably come to about $8 million or $9 million in 1984, triple the value of exports when U.S. administration began nearly 40 years ago. When inflation is figured in, however, the value of exports today is probably not much greater than it was in 1948.

Looking at the Future

Although the value of exports has increased only modestly, there are some promising signs that the Micronesian governments may generate income in other ways. For several years now, the three governments have negotiated with Japan for yearly payments in exchange for fishing rights in the territorial waters of these Micronesian countries. The three governments received a total of $4.5 million in 1984 for these rights (personal communications with government Martime authorities or equivalent offices). In addition, the Marshalls has recently negotiated an agreement with Japan to establish a base on Majuro to service the Japanese fishing fleet in the area. The new governments appear to be attempting to promote development more through lease rights and the establishment of a service economy than through the production of local goods for export. There has also been recent hotel expansion in Palau in anticipation of a buildup of its tourist industry.

Some modest attempts have been made at import substitution through small local industries. Pohnpei has a small bottling industry and has lately begun to make zories. Its small coconut processing plant produces soap and oils, an experiment duplicated in Truk within the last two years. Sakau bars have replaced the taverns that were formerly numerous throughout Kolonia in Ponape. Coconut milk (from coconut stores on Yap) have cut into the soft drink market. These initiatives have made very small inroads so far, but they may point to viable directions for the future.

As the new Micronesian governments prepare for Free Association, they look back on a 40-year U.S. administration with startling reversals of direction. The economy is almost as stagnant now as it was during the 1950s. For the past 10 years, the U.S. administration has sought private capital in the hope of developing industry, but the lack of resources and the islands' isolation from major markets continue to discourage potential investors, as have the relatively high labor costs that have accompanied the steady increase in wages in the public sector. The large and costly governments that are the legacy of the U.S. administration are a staggering financial burden. But they are also the major employers and the base on which the economy, including the present service-oriented private sector, rests. The most rapidly expanding part of the private sector has been the wholesale and retail companies.

As lopsided as growth has been in Micronesia, the standard of living (at least as measured in dollar terms) has risen under U.S. administration far more than any time in the islands' history. The latest reliable figures (1979) showed that 19,000 people in Palau, the Federated States and the Marshalls had full time employment and earned a total of $42 million. Even at the height of the productive Japanese economy in the late 1930s, the

Micronesian people did not enjoy the level of material prosperity they now have. The problem is to ensure that it continues. [end excerpt]

C. THE COMPACT OF FREE ASSOCIATION

Compact Funding

Under the Compacts of Free Association voted in by the Micronesian plebiscites, America's underwriting of the Micronesian economy will continue and initially rise. It has been estimated that U.S. assistance to Micronesia on a per capita basis is 11 times greater than Australian assistance to Papua New Guinea and 19 times greater than British assistance to Kiribati when these Pacific dependencies initially became independent.[12] Had the Compact been in place in 1983, the year it was approved in popular referendums in the Marshalls and the Federated States, the Micronesian states as a whole would have received a 17 percent increase in total U.S. grant assistance (Table 18). This increase will be higher in the amended Compact as signed into law by President Reagan. Additional funding will be provided for the first 3 years as a transition measure in phasing out Federal programs for education as well as an Investment Development Fund to compensate for less beneficial tax and trade provisions (Congressional Record, December 1985) Funding for capital improvements would have almost doubled, while funding for social welfare programs and the government bureaucracy would have actually decreased by 7.6 percent. The retargeting of funding primarily to infrastructure projects is a major stated aim of the Compact, one geared toward providing a base for future local productive industries and toward Micronesia's greater self-reliance.

Unfortunately, increased aid is unlikely to spur commercial development of local resources. To provide that incentive, U.S. assistance (measured in constant dollars), though initially raised, will decline throughout the first 15 years of Free Association, except in Palau. Its negotiators elected not to "front load" U.S. assistance, rather to spread it evenly over the 15-year period.

Reducing and retargeting aid will amount to another major reversal of U.S. economic policy (from previous trends of rapidly expanding aid primarily for social welfare and support of a burgeoning government bureaucreacy). This change is needed, but will undoubtedly create frictions as Micronesians try to adapt from a white collar service economy to an economy requiring trade skills. Scheduled decreases in aid measured in per capita terms will be substantial for the Marshalls and the Federated States (Tables 19 and 20,

---

[12] Larmour.

Figures 6 and 7). In the Marshalls, a good deal of U.S. funding that is to be available will be concentrated among Kwajalein landowners and nuclear testing victims (12.5 percent and 36.6 percent of the funding, respectively) (United Nations Trusteeship Council, T/1865, 1984).

Presently, Palauans and Marshallese have a higher per capita assistance ($1,050 and $1,242, respectively) than the citizens of the Federated States ($779), and this will continue under the Compact (Table 20). The Federated States will also experience the greatest decline in grant assistance (measured in real dollars) with a 62 percent drop over the 15-year period; the Marshalls will decline by 58 percent, and Palau by 20 percent. These sizeable reductions in aid will be responsible for a third of the projected drastic decline in per capita incomes in Micronesia. Population growth will be responsible for half this projected decline. In the Federated States and the Marshalls, annual population growth rates are three or more percent. In Palau, it is roughly one percent. However, Palau's low growth rate is due in large part to high levels of emigration to the United States, principally Guam.

Assuming no future additions to the Compact's economic package, then the United States would have successfully set a limit on future aid to Micronesia.

The Future Crisis

Can Micronesians, whose growing populations and rising material desires have been supported externally for the past generation, create a local economic base to compensate for the scheduled declines in U.S. assistance? This is the question inherent in the Free Association package, and it will be raised in real terms in only five years when the first major reduction in U.S. funding is initiated.

It is extremely unlikely, if not impossible, for the Micronesians, at least in the Federated States, to compensate completely. The productive sector of the Federated States would need to grow almost 10 percent per annum for the next 15 years just to maintain current per capita incomes (Table 21 and Figure 8). Only a few economies, such as Japan's in the 1960s, have achieved such high and sustained growth rates. Even if the Federated States develops commercial ventures with a 12 percent return on at least half of the Compact's investment funds, they will still need $40 million in external funds annually to maintain real per capita incomes at the end of 15 years.[13]

It is inevitable that the Micronesians will seek additional assistance from the United States in the future. How the United States, and in particular the Congress, responds to their requests will in large measure decide whether or not Micronesia can progressively achieve a higher level of economic self-reliance.

---

[13] Schwalbenberg, "The Economic Implications of Free Association," p. 97.

Future Options--Local Economic Development

The Compact provides several avenues for maintaining national per capita income despite reduced U.S. funding. The first is local economic development. Almost 40 percent of U.S. assistance is earmarked for infrastructure and development projects to build a foundation for economic growth. The Compact provides free access to the U.S. market for most goods. Canned tuna packed in water has duty free access as long as imports do not exceed 10% of the U.S. market, an unlikely event. However, textiles and a small number of other goods will not receive duty free treatment (Congressional Record, December 1985). There are also tax incentives for American private investment in Micronesia. To avoid mismanagement and misuse of funding,[14] the Micronesians must write development plans subject to U.S. review. They are also required to make annual reports on their use of U.S. funding. The U.S. has the right to audit such funding.

Nonetheless, there are several potential problems with the application of these development funds. The most recent development plan for the Truk islands allocates the bulk of development funding to local municipal councils. This brings to mind the patronage systems practiced by the political machines of several American cities in the last century, not a design to spur economic growth. Furthermore, the Federated States are given great latitude over the use of capital account funds under a subsidiary agreement (Fiscal Procedures Agreement) to the Compact. Development money can be used for emergency job programs which can be renewed indefinitely. Such make-work employment could simply divert needed productive investment into salaries and nonessential consumption.

Even should the money be put into needed infrastructure, this may not spur economic growth in Micronesia. Large-scale capital infrastructures can overwhelm a Pacific island economy, perpetuate dependency on external finance, and serve to increase consumption more than production. Truk's power plant provides an example. Like most infrastructures, it is located in the administrative center on Moen island. Since Moen's population is small, overall electrical needs are limited. Peak demand in Truk never surpasses two megawatts, and only small-scale and inefficient production using diesel generators is feasible. Unfortunately, the smaller the scale of energy production, the higher the unit costs of production. It is impossible to produce electricity in Micronesia for anywhere near the costs typical of the United States, Japan, or Europe. Truk's state government subsidizes electricity generation with $1.4 million annually, only slightly less than the amount generated by Truk's total productive economy (Table 22).

---

[14] William L. Heston, Managing Director, "Formal Report on our Examination of the Congress of the Federated States of Micronesia State Project Appropriations Enacted into Law for Fiscal Years 1980 and 1981," Touche Ross & Co., Saipan, 11 May 1982.

The power plant has undermined Truk's economy in other ways. About 60 percent of all electricity on the island is used by a small proportion of the population primarily for air conditioning and lighting homes and government offices. Private businesses use about 34 percent of Truk's electricity, primarily to refrigerate perishable imported food. Only six percent of the electricity in Truk is used in processing and exporting local goods (i.e., refrigerating fish for sale to local and foreign markets) (Alexander, 1982).

Truk loses three times as much money to the outside world in producing electricity as it earns from its number one export--copra. This bias toward consumption over production further magnifies an already serious deficit in the balance of trade, one that mandates outside assistance. If the costs of diesel fuel imports are taken into account, electrical production in Truk creates an annual trade deficit of $1.7 million (Alexander, 1982). Its major effect is to provide nonessential consumer goods to the island's higher income groups. The consumption benefits of large-scale infrastructure, in fact, usually accrue to the higher income groups living in Micronesian towns.

Another troublesome issue is that of replacing worn out infrastructure. Truk's power system cost $3.2 million to build. It will require an average of $400,000 per year over its life span for replacement costs (Alexander, 1982). This represents a big chunk of the state's budget, and strains the local indigenous cash economy (which only produced $2 million in 1981). Without American assistance, such large-scale infrastructure would simply have to be abandoned and allowed to rust once it reaches the end of its life span.

Thus, several factors argue against large infrastructure projects. First, small and scattered populations make economies of scale difficult. Second, Micronesia's limited productive base restricts the economy's capacity to productively use large injections of capital. Capital inputs that cannot be so absorbed will necessarily be directed toward imported consumer goods.

Finally, the small productive economy that does exist cannot support the operating subsidies and trade deficits caused by large infrastructure projects. Such projects, while providing a quick entry into the modern consumer society for Micronesia's elite, necessitate continued dependence on the U.S. Treasury.

Future Options--Exploitation of Resources

Although the economic exploitation of Micronesia's natural resources may prove difficult, the Japanese experience has shown that it is at least physically possible. Truk's local indigenous cash economy is producing a per capita GDP of roughly $90 (Schwalbenberg, 1982). Similar South Pacific island economies with limited resources and minimal foreign aid have on average a per capita GDP or about $400 (Schwalbenberg, 1982). If Truk is typical of Micronesia, these figures imply that Micronesia might be able to expand its productive economy by a factor of four. If Truk did expand its local economy by a factor of four, however, it would still not be able to generate a third as much (in per capita income) as it currently receives from the United States.

Although the possibility of completely replacing U.S. assistance with a local productive economy seems dim, there does seem to be substantial room for reducing dependence on the U.S. taxpayer and for fostering a more self-reliant and productive Micronesia.

Future Options--Foreign Affairs

A third avenue for increasing national income lies in the foreign affairs provisions of the Compact. The Compact recognizes the Micronesian governments as fully capable of conducting foreign affairs (specifically relating to the law of the sea and marine resources) so long as they do not interfere with American military and security concerns. Under the Trusteeship and with the consent of the United States, Micronesian governments are now conducting negotiations on such items as fishery agreements and foreign aid and investment, primarily with Japan, but also with the United Kingdom, Taiwan, the Philippines and their neighbors to the south. Under Free Association these activities and the foreign assistance they generate will most likely expand.

Future Options--Outmigration to the United States

A fourth avenue for increasing national income lies with the migration provisions of the Compact. Under the Compact, Micronesians will be legally free to enter, take employment, and reside indefinitely in the United States, although some restrictions on migration into U.S. territories can be imposed. The Compact also provides one form of temporary immigration which could become permanent--jobs in the U.S. armed forces for any Micronesian who meets the basic qualifications. Such migration can raise per capita income on the islands by lowering their resident populations and through the partial remittance of salaries earned in the United States. In the long run, migration could inhibit economic growth by depriving the islands of needed human resources. It is often the most economically productive who migrate.

Current migration patterns vary greatly among the Carolinians and the Marshallese. At one extreme is Palau; roughly one out of every five Palauans has left (Schwalbenberg, 1984d). Almost half of Palau's emigrants are in Guam, making it the largest Palauan community in the world outside of Koror (Palau's capital). Most Palauan emigrants to the United States remain permanently.

At the other extreme are the Marshallese; there are only a very few emigrants in Guam and the U.S., and many students look forward to their eventual return to the Marshalls. Data on Truk are mixed, possibly showing the beginning of a migration pattern to the United States.[15]

Should outmigration rates in the Marshalls and the Federated States approach that of Palau, decreasing population pressures and increasing remittance flows could potentially reduce Micronesia's need to generate future earnings (to compensate for the scheduled reductions in U.S. aid) by 21 percent (Schwalbenberg, 1984d).

There is also a significant immigration into Micronesia. Skilled immigrants (largely Filipinos) are an important labor resource on the islands (Schwalbenberg, 1984d). The influx of American money for public works has created employment opportunities for which Micronesians have neither the skills nor, in some cases, the discipline and motivation. As talented Micronesians have been siphoned off into well-paying but unproductive government jobs, to the United States, or into idle dependence on job-holding relatives, the Filipino immigrant has filled the gaps, in terms of productive work. These immigrants could provide the backbone of a future productive Micronesia.

Future Options--Additional U.S. Assistance

A final avenue for increasing national income is assistance from the U.S. Congress. It seems clear that some additional financial assistance will be needed in the future. Without it, the drastic reductions scheduled in the Compact would likely destabilize the region and pose an immediate threat to U.S. security interests. In general, there are two ways the United States can resolve this issue. One would be to continue the economic policy of the last 20 years of Trusteeship. This policy of rapidly increasing levels of U.S. aid, primarily to social services, undermines local incentive for commercial development.[16] Kiste has documented how abundant U.S. assistance undercut the initial efforts to develop a self-reliant community of displaced Bikinians on Kili.[17] Metzgar and Hezel have recorded how large-scale free food distribution in Truk reduced subsistence fishing between 50 percent to 66 percent by the families surveyed.[18] There is little evidence that U.S. policy promoted the development of a locally productive economy.

---

[15] Hezel, "In the Aftermath of the Education Explosion."

IV. CONGRESSIONAL RECOMMENDATIONS

A different policy, based more on the Japanese experience, is recommended here as a better means to foster Micronesian economic development and in the long run protect America's humanitarian and security interests in the region. Such a policy would foster, to the extent possible, the economic exploitation and management of local resources, and would have three main foci: the gradual but determined curtailing of that American economic assistance which perpetuates dependency; the provision of ample incentives and assistance to support the commercial development of the islands; and the safeguarding of a limited number of essential public services.

CURTAILING DEPENDENCY

By the sixth year of the Compact, the financial arrangements of Free Association will most probably prove unworkable in the Federated States and the Marshalls due to abrupt and severe scheduled cuts in U.S. funding. At this turning point, it will prove necessary to provide additional funding. It is essential, however, that overall funding (with exceptions for a limited number of essential public services) be reduced gradually and continuously. Various options are available. Following the Australian/Papua New Guinea pattern, overall funding would be reduced beginning in year six by a fixed percentage subject to consultation with the Micronesians but hopefully in the range of three to five percent (Johnson, 1983). The effects of population growth and inflation could be taken into account, but in no case should there be an increase in U.S. assistance on a real per capita basis. Also this reduction should not take into account any commercial development in the islands. Reductions in U.S. assistance cannot become a penalty incurred for commercial development if it is to stimulate production.

---

[16] Most of Hezel's articles deal with this point. Also see Fisk, "Motivation and Modernization."

[17] Kiste, 1974.

[18] Micronesian Seminar, "U.S. Federal Programs...," p. 18.

It is important that the United States not fund certain types of assistance that the Micronesians might request, including assistance for land payments, for the raising of government wage rates, and for free food assistance. The negative effect of free food distribution on incentives has already been noted. The raising of government wages without reference to productivity will continue to keep Micronesian labor uncompetitive and necessitate ongoing importation of Asian labor for Micronesian industries. U.S. assistance should aim to achieve the Japanese goal of limiting salary expenditures to a small percentage of the funding. Finally, land payments are pure economic rent, having no positive economic value. They often have a negative effect on income distribution since they are usually large and go to a few.

SUPPORT OF COMMERCIAL DEVELOPMENT

As overall U.S. assistance is gradually reduced, any additional funding should be targeted toward investments that can expand the productive capacity of these islands. There should be no additional funding for new capital improvements projects unless it can be demonstrated that they meet strict economic criteria, namely some positive rate of return on the investment[19], and not just the political needs of the Americans and the Micronesian elites.[20] Given Micronesia's already large investment in infrastructure, future U.S. assistance in this area should probably be targeted for maintenance rather than expansion.

Following the Japanese example, U.S. funding can also help subsidize private industry. The Japanese experience showed the necessity of subsidizing Micronesian industries in their early stages. The Japanese directed 22.3 percent of their expenditures to subsidize private companies involved in the commercial utilization of Micronesian resources. The United States should consider a similar commitment of funds and welcome Micronesian funding requests along these lines in the future.

---

[19] Comptroller General, p. 18

[20] See Solomon, 1963 and Schwalbenberg, "CIP Funding: For Economic Development or Political Consumption."

To the full extent possible in the future, additional tariff benefits and investment incentives, if requested, should be extended to Micronesia. However, lowering local content requirements is not quite as important as enabling Micronesians to export a large range of commodities to U.S. markets. If local content of Micronesian exports is too low then the islands will simply become a transshipment site with little direct economic benefit for local Micronesians.

Micronesian future requests for additional tax exemptions should only be made if they will promote private productive investment in Micronesia. To indiscriminately make Micronesia a tax haven for Americans is simply to provide another kind of transfer payment. Various trade and investment programs such as those of the Overseas Private Investment Corporation and the U.S. International Development Corporation Agency may also benefit Micronesian economic development.

SAFEGUARDING ESSENTIAL PUBLIC SERVICES

Future reductions in overall funding and the retargeting of funding away from the Micronesian government bureaucracies, pose the real danger that the Micronesian governments might cut essential public services in order to increase government wage rates. Funds urgently needed to fight the 1982-83 cholera eipdemic in Truk were siphoned off into salaries of local government workers through false reporting of work hours.[21] If this sort of thing can occur with the current high levels of U.S. funding, it is even more likely to happen when funding is restricted.

It may therefore prove necessary to ensure the availability of essential medical and other public services that Micronesians cannot provide themselves. The Compact agreement does target funding specifically for energy costs, disaster relief, communications, weather monitoring, postal services, and various medical and educational programs. Guaranteed funding may also be needed in the future to cover the fuel costs of field ships and adequate supplies of medicines. Such funding should be monitored carefully to ensure compliance.

On the other hand, services and goods which the Micronesians can provide from their own resources such as labor, land and food should not be paid for or supplied by the United States.

---

[21] John Dye. State of Truk Cholera Aid Program. FSM Office of Public Auditor Report 83-2, April 18, 1983

CONCLUSION

During Free Association, the United States can either perpetuate Micronesian dependency or foster Micronesian self-reliance. Although the Micronesians will have primary responsibility for their own welfare, when they seek help to develop a more self-reliant economy and to create a more pluralistic society, they should find a willing partner in the United States. On the other hand, when they seek only easy access to U.S. funding for the benefit of a small elite, they should be refused. This paper recommends that the U.S. government not deviate in the future from its new three prong economic policy implicit in the Compact of Free Association, namely the curtailing dependency by gradually reducing U.S. transfer payments, the support of commercial development through investment incentives and trade benefits, and the safeguarding of a limited number of essential public services. This approach would be consistent with both American and Micronesian desires for Micronesian security, sovereignty and self-reliance, the three fundamental goals of Free Association.

APPENDIX A

MARIANAS

The largest industry in these islands, as in the entire Mandate, was the sugar industry. In 1937, the value of the sugar in the Marianas came to about 21.2 million yen for sugar and molasses. Root crops were also grown for the production of starch, valued at 530,000 yen in 1937. Coffee was grown as well as other crops, the total value of which was another 150,000 yen. Copra produced 115,000 yen. Some mining of phosphate was done on Saipan, Rota, Agrihan and Medinilla, and 14,000 tons valued at 230,000 yen were mined in 1937. Commercial fishing accounted for 1.1 million yen, with most of this coming from the dried bonito industry. There was a small lumbering industry, and some animal husbandry, and various other smaller type industries. The total export value for the Marianas in 1937 was 23.7 million yen of a total 37.3 million. This was an increase of 10 million yen over its exports of 14 million in 1934.

PALAU

There was considerable commercial agriculture done in Palau during the 1930s, with a great variety of crops grown. The total value of crops grown in 1937 was 450,000 yen, with the most important ones being tapioca, sweet potatoes and taro--used for starch. The export value of crops was 190,000 yen. Copra accounted for 150,000 yen. Livestock was also raised in Palau, and a slaughterhouse built there. Phosphate was produced and accounted for the greatest source of Micronesian income; in 1937, phosphate exports were valued at 2.1 million yen. There were 91,000 tons from Anguar, 26,000 from Peleliu, and another 1,500 from Tobi produced. Aluminum was discovered and mined in Babeldaob from the late 1930s; 25,000 tons was expected yield in 1937. Lumber and wood products brought another 14,000 yen in exports. Commercial fishing totaled 5.1 million yen, making it the most important industry in Palau. Two million yen came from dried bonito, and another 3.1 million came from shellfish. This included the sale of trochus and other shells used to make cuttons, cultured pearls, and production of turtle shell. In addition, there were a number of smaller industries such as the production of cord for export. Palau had one of the most diversified economies during this period. Its total production came to about one-fourth of the entire Mandate, and its exports in 1937 totaled 7,906,000 yen. This is an increase from 4.5 million yen in 1934.

YAP

Some commercial agriculture was done to the value of 76,000 yen in 1937, but none of this was exported. There was also some livestock raised, as in Palau, and slaughtered for the meat. Phosphate deposits were discovered on Fais and began to be mined in 1938. They produced 14,000 tons that year, and 44,000 tons the following year. Copra brought in 190,000 yen, while lumbering and charcoal production accounted for 9,000 yen more. Commercial fishing in Yap could not be compared with Palau in scale; Yap produced 19,000 in revenue through shell in 1937. The total export value for Yap in 1937 was 220,000 yen. The export value decreased slightly from 1934.

TRUK

The largest industry in Truk was the fishing industry. In 1937, manufactured marine products were valued at 2,195,000 in all. Besides the usual dried bonito processing, there was also a canning operation located on Toloas. There was no commercial agriculture at all to speak of, and the forestry industry brought in only 10,000 in 1937. Manufacture of rope brought in 100,000 yen, and copra produced 670,000 yen. Total exports in 1937 were 3,049,000 yen. This is double the value of exports in 1936 (1,421,000 yen) and quintuple the value in 1934 (627,000).

PONAPE

The largest industry on Pohnpei was the dried bonito and fishing, which in 1937 produced 450,000 yen worth of fish products. The second largest industry was starch production, begun in 1934. Sweet potatoes, arrowroot and other tubers were grown on Pohnpei for the making of starch, but by the late 1930s tapioca was the main crop grown for this purpose. About 1,300 acres were planted in tapioca, and in 1937 nearly 2,000 tons of processed starch were exported at a value of about 200,000 yen. There were also considerable amounts of vegetables grown, but these were consumed locally. Lumber, charcoal and other forest products were also turned out, but their export value was negligible at 15,000 yen yearly. Copra brought in about 660,000 yen. In 1938, the starch acreage was converted to sugar; before this time there was no sugar production on the island. There was also some aluminum mining on a small scale. Total exports in 1937 were 1,538,000 yen. This figure tripled since 1934 when exports totalled 554,000 yen.

KOSRAE

Other than copra, little was produced there. An attempt to raise sugar there in 1938 failed completely, and attempts to do truck gardening there the following year came to nothing because of insects. Exports in 1937 were 125,000 yen. This was almost all copra (122,000 yen).

MARSHALLS

The largest industry by far was copra, which amounted to an export value of about 600,000 yen a year during the 1930s, and about 800,000 yen in 1936. There is also some commercial fishing, with exports of about 55 tons yearly. Some dried bonito was sold, and a small cannery was established on Jaluit. There was a small supply of phosphate on Ebon that was mined, but this was inconsequential. Exports in 1936 were 890,000 yen.

FOOTNOTES

[1] Analysis of the military importance of Micronesia can be found in John Dorrance, "United States Security Interests in the Pacific Islands," February 1984, reprinted in Hearing on National Security Implications of the Compact of Free Association, before the Subcommittee on Public Lands and National Parks, 98th Cong., 2d Sess., August 7 and 9, 1984, 203-223; John Dorrance, Micronesian Crosscurrents and the U.S. Role in the Western Pacific, The National War College, Washington, D.C., 20319, 1975; and Henry M. Schwalbenberg, S.J., "American Military Needs in Micronesia: Valid Perceptions or Unnecessary Contingencies?" Memoranda on the Compact of Free Association, Truk, Caroline Islands: Micronesian Seminar, October 1982.

[2] See Arthur John Armstrong and Howard Loomis Hills, "The Negotiations for the Future Political Status of Micronesia," American Journal of International Law, Vol. 78, No. 2, April 1984; and Henry M. Schwalbenberg, S.J., "FSM and Denial," Pacific, March/April 1983.

[3] See the development plans of either the Federated States or the Marshall Islands for a national income accounting breakdown.

[4] A new approach is called for. Marshall Sahlins of the University of Chicago and E. K. Fisk of the Australian National University are perhaps the foremost students of the traditional economies among Pacific islands. In large part the following discussion of the traditional Micronesian economy is an oversimplified summary of their work.

[5] Fisk, 1982, p. 10.

[6] Sahlins, 1971.

[7] Fisk, 1982, p. 9.

[8] Fisk, 1982, p. 11.

[9] Fairbairn and Tisdell, no date.

[10] Hezel, "A Brief Economic History of Micronesia," 1984.

[11] Hezel and Berg, pp. 495-496.

[12] Larmour.

[13] Schwalbenberg, "The Economic Implications of Free Association," p. 97.

[14] William L. Heston, Managing Director, "Formal Report on our Examination of the Congress of the Federated States of Micronesia State Project Appropriations Enacted into Law for Fiscal Years 1980 and 1981," Touche Ross & Co., Saipan, 11 May 1982.

[15] Hezel, "In the Aftermath of the Education Explosion."

[16] Most of Hezel's articles deal with this point. Also see Fisk, "Motivation and Modernization."

[17] Kiste, 1974.

[18] Micronesian Seminar, "U.S. Federal Programs...," p. 18.

[19] Comptroller General, p. 18

[20] See Solomon, 1963 and Schwalbenberg, "CIP Funding: For Economic Development or Political Consumption."

[21] John Dye. State of Truk Cholera Aid Program. FSM Office of Public Auditor Report 83-2, April 18, 1983

VI. BIBLIOGRAPHY

Alexander, Aniol, et al, "Truk State Electrical System," TOWN STUDY REPORTS, Truk, Caroline Islands: Xavier High School, 1982.

Alexander, William John, WAGE, URBANIZATION AND CULTURE CHANGE IN THE MARSHALL ISLANDS: THE EBEYE CASE. Ph.D. dissertation. New School for Social Research, 1978.

Borthwick, Mark. "Assessing the Impacts of Technological Projects and Evaluating Social Programs in Micronesia," presented at the Micronesian Seminar Conference on US Federal Programs, Kolonia, Ponape, March 12-14, 1979, on file Micronesian Seminar Library.

Comptroller General of the United States, THE CHALLENGE OF ENHANCING MICRONESIAN SELF-SUFFICIENCY. Washington, D.C.: General Accounting Office, ID-83-1, January 25, 1983.

Congress of Micronesia. FIVE-YEAR INDICATIVE DEVELOPMENT PLAN (1976-1981). JULY 1976.

Connell, John. "Remittances and Rural Development: Migration, Dependence and Inequality in the South Pacific," AUSTRALIAN NATIONAL UNIVERSITY DEVELOPMENT STUDIES CENTRE OCCASIONAL PAPER NUMBER 22, Canberra, 1980.

-------------. "Federated States of Micronesia," MIGRATION PROJECT. South Pacific Commission. 1984.

-------------. "Marshall Islands," MIGRATION PROJECT. South Pacific Commission. 1984.

-------------. "Palau," MIGRATION PROJECT. South Pacific Commission. 1984.

Fairbairn, T'eo Ian and Clem Tisdell. "Economic Growth Among Small Pacific Countries: Can it be Sustained?" Mimeographed paper on file at the Micronesian Seminar Library, Truk, Caroline Islands, no date.

Federated States of Micronesia. FIRST NATIONAL DEVELOPMENT PLAN 1985-1989. Kolonia, Pohnpei: Office of Planning and Statistics, 1985.

Fisk, E.K. "The Response of Non-monetary Production Units to Contact with the Exchange Economy," in L.G. Reynolds, ed., AGRICULTURE IN DEVELOPMENT THEORY. Yale University Press, New Haven, 1975, pp.53-83.

__________. "Motivation and Modernization." PACIFIC PERSPECTIVE. Volume 1, Number 1, 1972.

---------. "Subsistence Affluence and Development Policy," REGIONAL DEVELOPMENT DIALOGUE. Nagoya, Japan: United Nations Centre for Regional Development, Special Issue, 1982.

Goodman, Grant K. and Felix Moos, eds. THE UNITED STATES AND JAPAN IN THE WESTERN PACIFIC: MICRONESIA AND PAPUA NEW GUINEA. Boulder, Colorado: Westview Press, 1981.

Harris, G.T. "Food Imports and Marcoeconomic Policy in the South Pacific, THE DEVELOPING ECONOMIES. Tokyo, Japan: Institute of Developing Economies, Volume XXII, Number 1, March 1984, 70-85.

Hezel, Francis X., S.J. "Creation of a Colony: The Paradox of Economic Aid to Micronesia (1968)," REFLECTIONS ON MICRONESIA: COLLECTED PAPERS OF FATHER FRANCIS X. HEZEL, S.J. Honolulu, Hawaii: Working Paper Series, Pacific Islands Studies Program, University of Hawaii, 1982. A

----------------------. "Reflections on Micronesia's Economy (1973)," REFLECTIONS ON MICRONESIA: COLLECTED PAPERS OF FATHER FRANCIS X. HEZEL, S.J. Honolulu, Hawaii: Working Paper Series, Pacific Islands Studies Program, University of Hawaii, 1982. B

----------------------. "The Micronesian Dilemma: How to Support Expensive Habits and Still Run the Household (1976)," REFLECTIONS ON MICRONESIA: COLLECTED PAPERS OF FATHER FRANCIS X. HEZEL, S.J. Honolulu, Hawaii: Working Paper Series, Pacific Islands Studies Program, University of Hawaii, 1982. C

----------------------. "Taking the Long View (1977)," REFLECTIONS ON MICRONESIA: COLLECTED PAPERS OF FATHER FRANCIS X. HEZEL, S.J. Honolulu, Hawaii: Working Paper Series, Pacific Islands Studies Program, University of Hawaii, 1982. D

----------------------. "The New Formula for Self-Reliance (1979)," REFLECTIONS ON MICRONESIA: COLLECTED PAPERS OF FATHER FRANCIS X. HEZEL, S.J. Honolulu, Hawaii: Working Paper Series, Pacific Islands Studies Program, University of Hawaii, 1982. E

----------------------. "Yesterday's Myths, Today's Realities (1980)," REFLECTIONS ON MICRONESIA: COLLECTED PAPERS OF FATHER FRANCIS X. HEZEL, S.J. Honolulu, Hawaii: Working Paper Series, Pacific Islands Studies Program, University of Hawaii, 1982. F

----------------------. "The Education Explosion in Truk," PACIFIC STUDIES. Volume 2, Number 2, Spring 1979.

---------------------- and Mark Berg, eds. MICRONESIA: WINDS OF CHANGE. Saipan: Trust Territory of the Pacific, 1980.

----------------------. THE FIRST TAINT OF CIVILIZATION. Pacific Islands Monograph Series, Number 1. Honolulu: University of Hawaii Press, 1983.

----------------------. "A Brief Economic History of Micronesia," PAST ACHIEVEMENTS AND FUTURE POSSIBILITIES: A CONFERENCE ON ECONOMIC DEVELOPMENT IN MICRONESIA. Kolonia, Ponape: Micronesian Seminar, May 22-25, 1984. pp.11-62.

----------------------. "In the Aftermath of the Education Explosion." Truk, Caroline Islands: Micronesian Seminar, 1985. A

----------------------. "Compact Vision Dims as Micronesians Fail to Bite the Bullet," MARSHALL ISLANDS JOURNAL. Volume 16, Number 15, 12 April 1985. B

----------------------. "Sale of Land," JUSTICE ISSUES IN MICRONESIA, NUMBER 1. Truk Caroline Islands: Micronesian Seminar, 1985. C

Japanese Government. ANNUAL REPORT TO THE LEAGUE OF NATIONS ON THE ADMINISTRATION OF THE SOUTH SEA ISLANDS UNDER JAPANESE MANDATE. 1926-1937.

Kent, George. "Development Planning for Micronesia," POLITICAL SCIENCE. 34:1-25, 1982.

Kiste, Robert C. THE BIKINIANS: A STUDY IN FORCED MIGRATION. Menlo Park, California: Cummings Publishing Company. 1974.

Larmour, Peter. "Compact of Free Association," PAPUA NEW GUINEA: FOREIGN AFFAIRS REVIEW. Volume 2, Number 2.

Micronesian Maritime Authority. SYNOPSIS OF BIOLOGICAL INFORMATION FOR SKIPJACK, YELLOWFIN AND BIGEYE TUNA AS WELL AS FOR SPECIES CAUGHT INCIDENTAL TO TUNA INCLUDING THEIR BIOLOGY, ABUNDANCE AND PRODUCTION POTENTIALS. Kolonia, Pohnpei: Micronesian Maritime Authority, Federated States of Micronesia, October 1983.

------------------------------. ASSUMPTIONS IN MANAGEMENT AND DEVELOPMENT OF THE OCEANIC FISHERY RESOURCES OF THE FEDERATED STATES OF MICRONESIA. Kolonia, Pohnpei: Micronesian Maritime Authority, Federated States of Micronesia, October 1983.

------------------------------. KNOWN OCEANIC FISHERY RESOURCES OF THE FSM, INCLUDING CURRENT EXPLOITATION OF THE MAJOR COMMERCIAL SPECIES. Kolonia, Pohnpei: Micronesian Maritime Authority, October 1983.

------------------------------. OBJECTIVES IN THE DEVELOPMENT OF THE FISHERY RESOURCES OF THE FSM. Kolonia, Pohnpei: Micronesian Maritime Authority, October 1983.

Micronesian Seminar. US FEDERAL PROGRAMS IN MICRONESIA: A REPORT ON A CONFERENCE. Kolonia, Ponape: Micronesian Seminar, March 12-14, 1979.

O'Connor, Donald J. AN ECONOMIC PERSPECTIVE OF THE TRUST TERRITORY OF THE PACIFIC ISLANDS. Washington, D.C., 1952.

Office for Micronesian Status Negotiations. COMPACT OF FREE ASSOCIATION AND SUBSIDIARY AGREEMENTS. Washington, D.C.: Office for Micronesian Status Negotiations, 1983.

--. DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE COMPACT OF FREE ASSOCIATION. Washington, D.C.: Office for Micronesian Status Negotiations, 1984.

Oliver, Douglas. ed. ECONOMIC SURVEY OF MICRONESIA. Washington, D.C.: US Commercial Company, 1947.

Peoples, James. ISLAND IN TRUST: CULTURE CHANGE AND DEPENDENCE IN A MICRONESIAN ECONOMY. Boulder, Colorado: Westview Press, 1984.

Petersen, Glenn. PONAPEAN AGRICULTURE AND ECONOMY: POLITICS, PRESTIGE, AND PROBLEMS OF COMMERCIALIZATION IN THE EASTERN CAROLINE ISLANDS. Ph.D. dissertation. Columbia University, 1977.

Purcell, David C., Jr. JAPANESE EXPANSION IN THE SOUTH PACIFIC 1890-1935. Ph.D. disseration. University of Pennsylvania, 1967.

---------------------. "The Economics of Exploitation: the Japanese in the Mariana, Caroline, and Marshall Islands, 1915-1940," JOURNAL OF PACIFIC HISTORY, 11(3), 1976, 189-211.

Republic of the Marshall Islands. FIRST FIVE YEAR DEVELOPMENT PLAN 1985-1989. Majuro, Marshalls: Nitijela Paper Number 1, 1984.

Richard, Dorothy. UNITED STATES NAVAL ADMINISTRATION OF THE TRUST TERRITORY OF THE PACIFIC ISLANDS. 3 VOLUMES. Washington, D.C.: Office of Chief of Naval Operations, 1957.

Sahlins, Marshall. "Tribal Economics," in ECONOMIC DEVELOPMENT AND SOCIAL CHANGE, edited by George Dalton, pp. 43-61. Garden City: American Museum of Natural History, 1971.

Schwalbenberg, Henry M., S.J. "Traditional Economic Systems and their Responses to Westernization," PAST ACHIEVEMENTS AND FUTURE POSSIBILITIES: A CONFERENCE ON ECONOMIC DEVELOPMENT IN MICRONESIA. Kolonia, Ponape: Micronesian Seminar, May 22-25, 1984A pp.2-10.

----------------------------. "The Economic Provisions of the Compact of Free Association," PAST ACHIEVEMENTS AND FUTURE POSSIBILITIES: A CONFERENCE ON ECONOMIC DEVELOPMENT IN MICRONESIA. Kolonia, Ponape: Micronesian Seminar, May 22-25, 1984 B pp.63-88.

----------------------------. "The Economic Implications of Free Association," PAST ACHIEVEMENTS AND FUTURE POSSIBILITIES: A CONFERENCE ON ECONOMIC DEVELOPMENT IN MICRONESIA. Kolonia, Ponape: Micronesian Seminar, May 22-25, 1984C pp.89-99.

----------------------------. "Micronesians on the Move: Guam or Hawaii?" reprinted in Hearing on General Law Provisions of the Proposed Compact of Free Association, before the Subcommittee on Public Lands and National Parks, 98th Congress, 2nd Session, 12 June 1984 D.

----------------------------. "CIP Funding: For Economic Development or Political Consumption," MEMORANDA ON THE COMPACT OF FREE ASSOCIATION. Truk, Caroline Islands: Micronesian Seminar, March 1982.

----------------------------. "Independence: The Challenge of Free Association," MARSHALL ISLANDS JOURNAL. Volume 15, Number 10, 3 February 1984 E.

Smit van Waesbergbe M.A.M. and P.J.M. Litjens. CONSUMPTION AND PRODUCTION IN THE TRADITIONAL SECTOR OF THE TRUST TERRITORY OF THE PACIFIC ISLANDS. Saipan, Mariana Islands: Office of Planning and Statistics, Trust Territory Headquarters, October 1981.

Solomon, Anthony, et.al. A REPORT BY THE US GOVERNMENT SURVEY MISSION TO THE TRUST TERRITORY OF THE PACIFIC ISLANDS. Parts I, II, and III. October 9, 1963.

Techur, Donna, et al, "Business Survey," TOWN STUDY REPORTS, Truk, Caroline Islands: Xavier High School, 1982.

Tun, Jonathan, et al, "Tourism in Truk," TOWN STUDY REPORTS, Truk, Caroline Islands: Xavier High School, 1982.

US Department of the Navy. CIVIL AFFAIRS HANDBOOKS (MARIANAS, MARSHALLS, EAST CAROLINES, AND WEST CAROLINES). Washington, D.C.: Office of Chief of Naval Operations, 1943-1944.

US Department of State. ANNUAL REPORT TO THE UNITED NATIONS ON THE ADMINISTRATION OF THE TRUST TERRITORY OF THE PACIFIC ISLANDS. Washington, D.C. 1948-1984.

US Department of the Treasury. "Treatment of the Freely Associated States as Possessions for US Tax Purposes," Hearing on General Law Provisions of the Proposed Compact of Free Association, before the Subcommittee on Public Lands and National Parks, 98th Congress, 2nd Session, 12 June 1984.

US House of Representatives. HEARING ON THE IMPACT OF THE PROPOSED COMPACT OF FREE ASSOCIATION ON ECONOMIC DEVELOPMENT IN MICRONESIA, held before the Subcommittee on Public Lands and National Parks, 21 May 1984.

Yanaihara, Tadao. PACIFIC ISLANDS UNDER JAPANESE MANDATE. London: Oxford University Press, 1940.

ADDITIONAL BIBLIOGRAPHIC ENTRIES

Dye, John. STATE OF TRUK CHOLERA AID PROGRAM, Office of the Public Auditor, Federated States of Micronesia, Report 83-2, April 18, 1983.

Heston, William L., Managing Director. "Formal Report on our Examination of the Congress of the Federated States of Micronesia State Project Appropriations Enacted into Law for Fiscal Years 1980 and 1981," Touche Ross & Co., Saipan, May 11, 1982.

Johnson, L.W. COLONIAL SUNSET: AUSTRALIA AND PAPUA NEW GUINEA 1970-74, St. Lucia, New York: University of Queensland Press, 1983.

Nathan, R.R. ECONOMIC DEVELOPMENT PLAN FOR MICRONESIA. Washington, D.C.: Robert R. Nathan Associates, Inc., 1966.

United Nations. ECONOMIC AND SOCIAL SURVEY OF ASIA AND THE PACIFIC 1984. Bangkok, 1985.

United Nations Trusteeship Council. REPORT OF THE UNITED NATIONS VISITING MISSION TO OBSERVE THE PLEBISCITE IN THE MARSHALL ISLANDS (T/1865). New York, 1984.

United Nations Trusteeship Council. REPORT OF THE UNITED NATIONS VISITING MISSION TO OBSERVE THE PLEBISCITE IN PALAU (T/1851). New York, 1983.

United Nations Trusteeship Council. REPORT OF THE UNITED NATIONS VISITING MISSION TO OBSERVE THE PLEBISCITE IN THE FEDERATED STATES OF MICRONESIA (T/1860). New York, 1984.

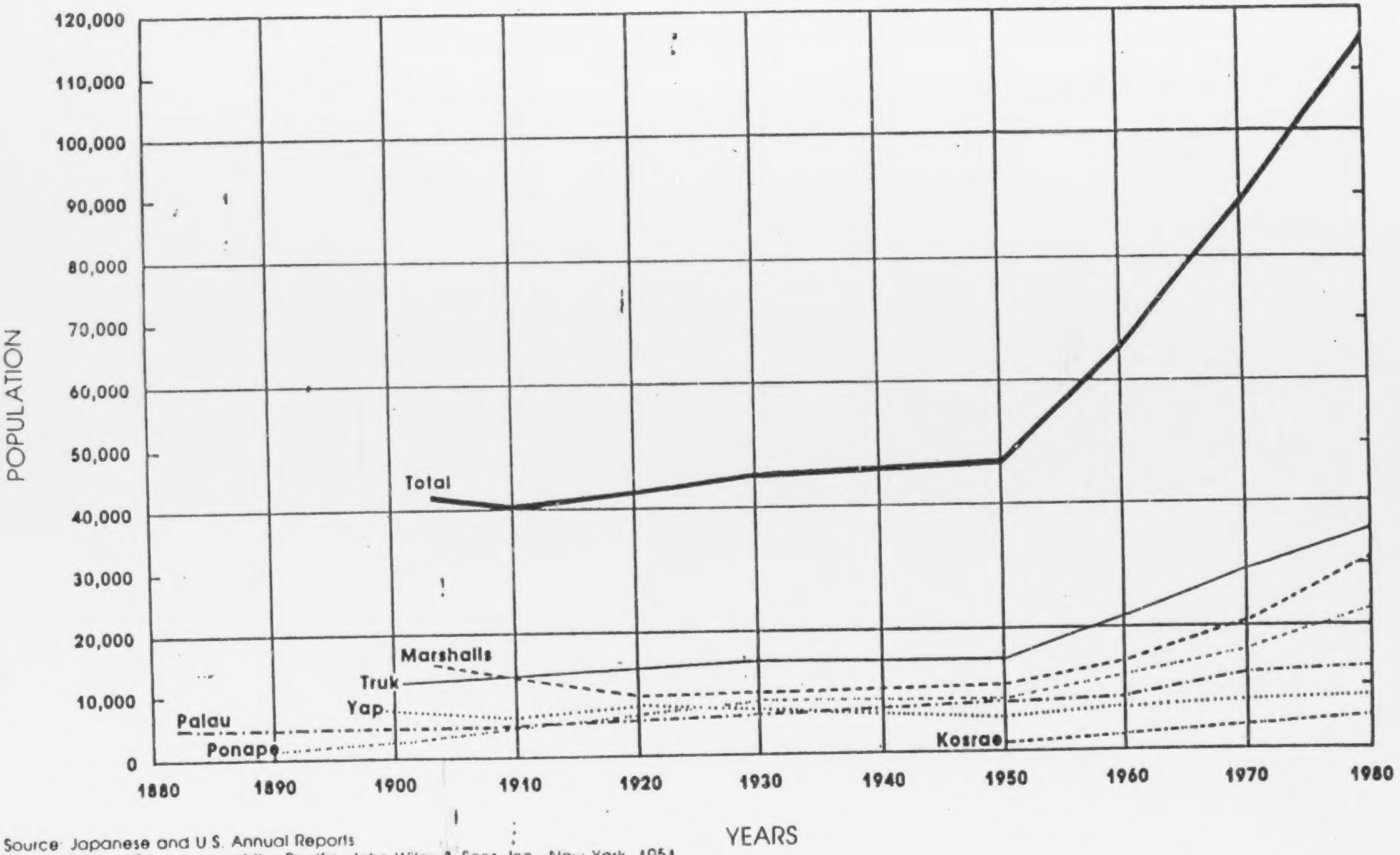
United States House of Representatives. CONGRESSIONAL RECORD. Volume 131, Number 101, July 25, 1985.

United States House of Representatives. CONGRESSIONAL RECORD. Volume 131, Number 171, December 11, 1985.

Stone, Julius. THE ATLANTIC CHARTER NEW WORLDS FOR OLD. Sydney: Current Book Distributors, 1945.

FIGURE 1

POPULATION, 1890-1980

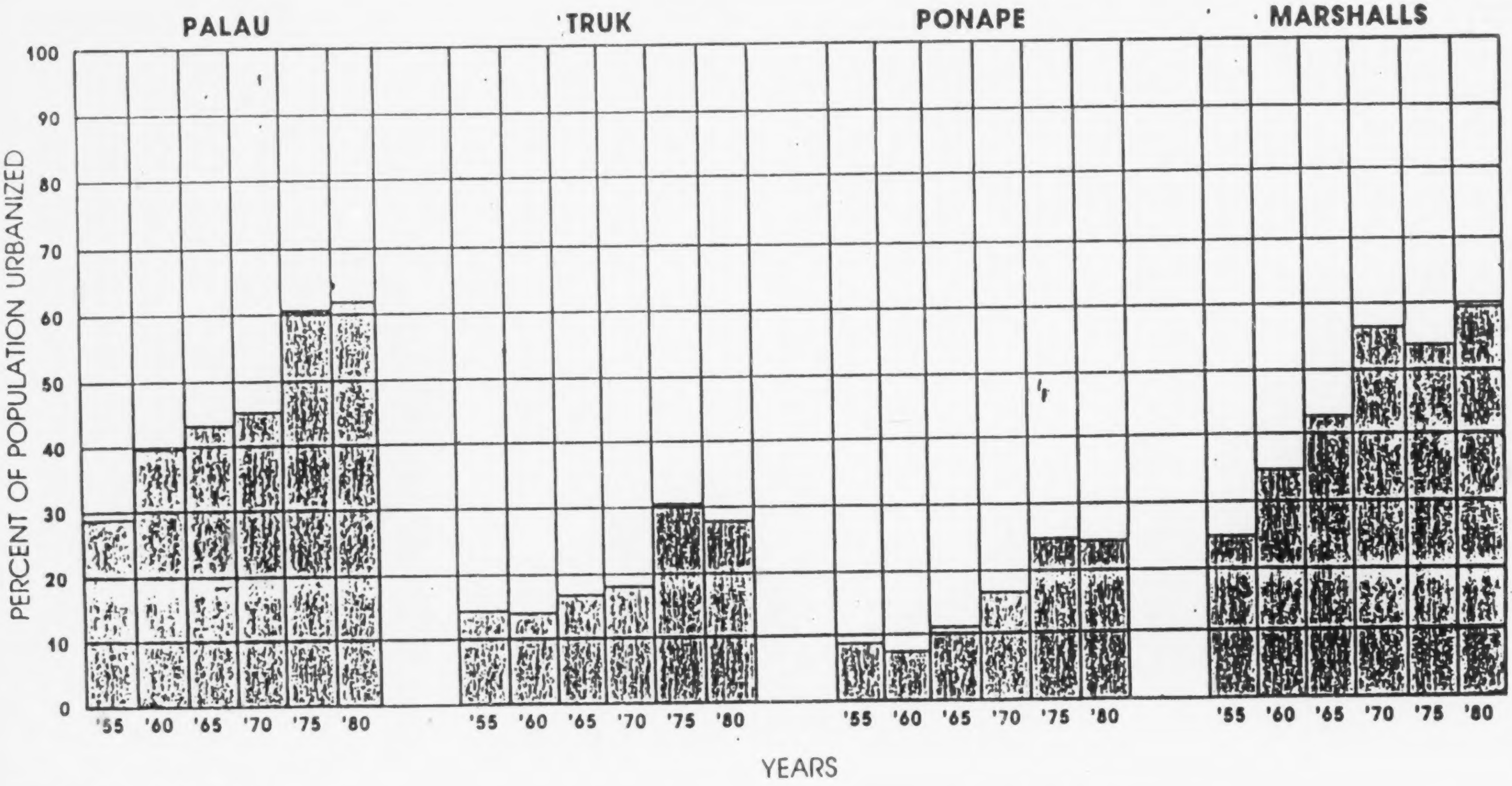


Source: Japanese and U.S. Annual Reports
O.W. Freeman, Geography of the Pacific, John Wiley & Sons, Inc., New York, 1951
German Reports for 1901 & 1903

FIGURE 2

URBANIZATION OF PALAU, TRUK, PONAPE AND THE MARSHALLS, 1950-1980

(Showing the percent of total population living in towns)

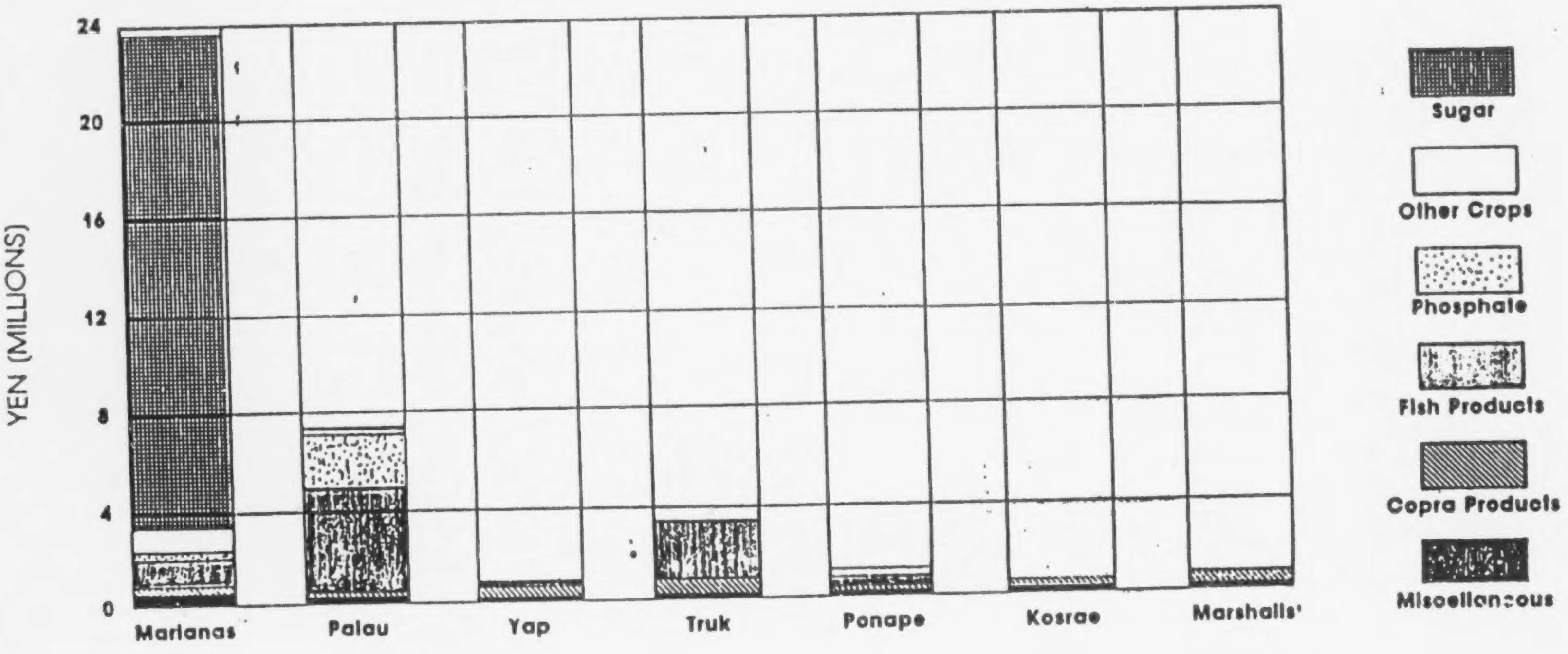


Source U S Annual Reports

FIGURE 3

EXPORTS BY ISLAND GROUP, 1937

(By value in millions of yen)

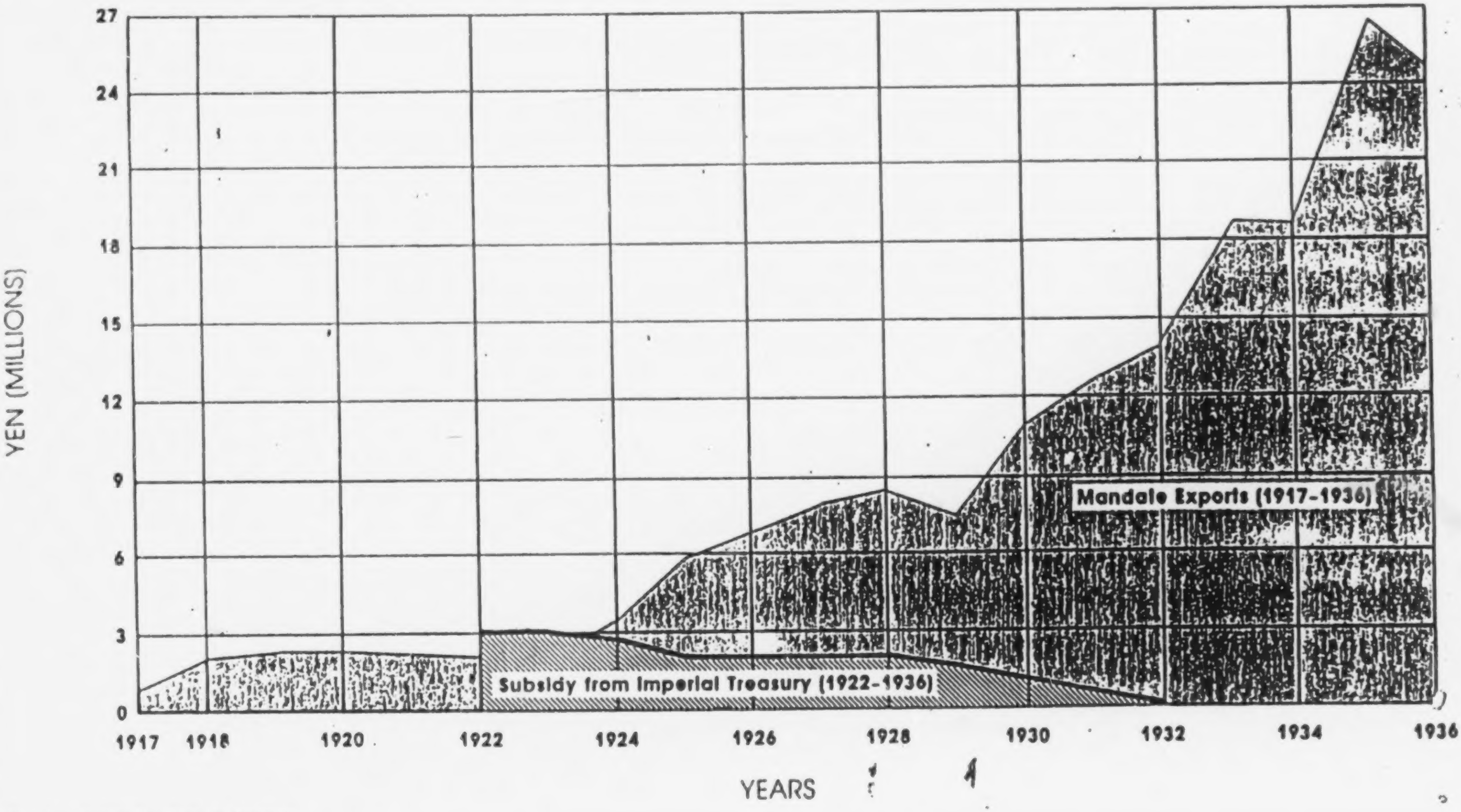


'Marshalls figures are for 1936.

Source U.S. Civil Affairs Handbooks (1943 & 1944)

FIGURE 4

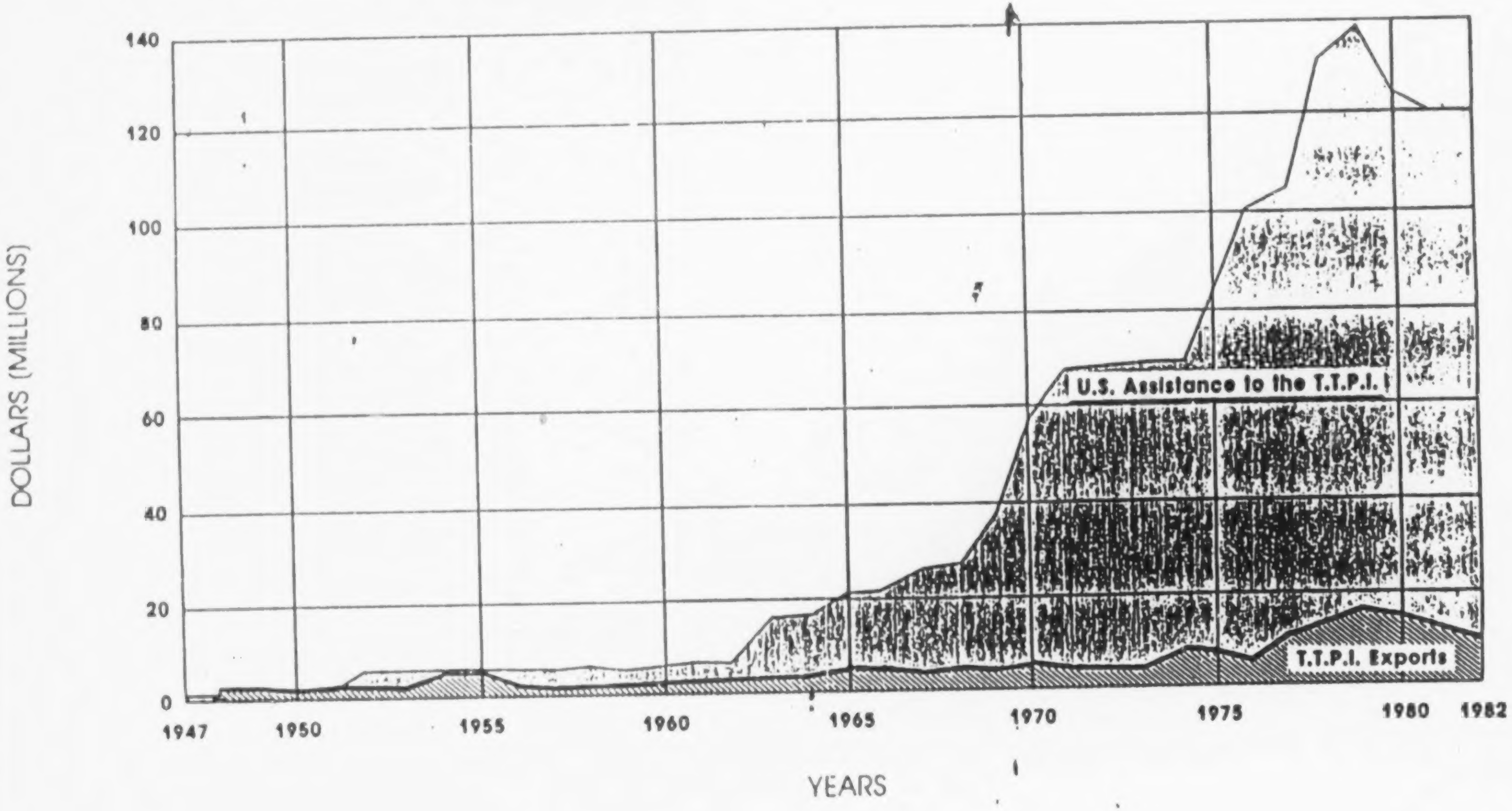
JAPANESE COLONIAL PERIOD, 1917–1936: IMPERIAL TREASURY SUBSIDY AND EXPORTS



Source: Japanese Annual Reports

FIGURE 5

AMERICAN COLONIAL PERIOD, 1947–1982: U.S. ASSISTANCE AND EXPORTS



Source: U.S. Annual Reports

FIGURE 6

PROJECTED PER CAPITA U.S. AID FOR F.S.M. UNDER THE COMPACT

(Constant 1981 dollars)

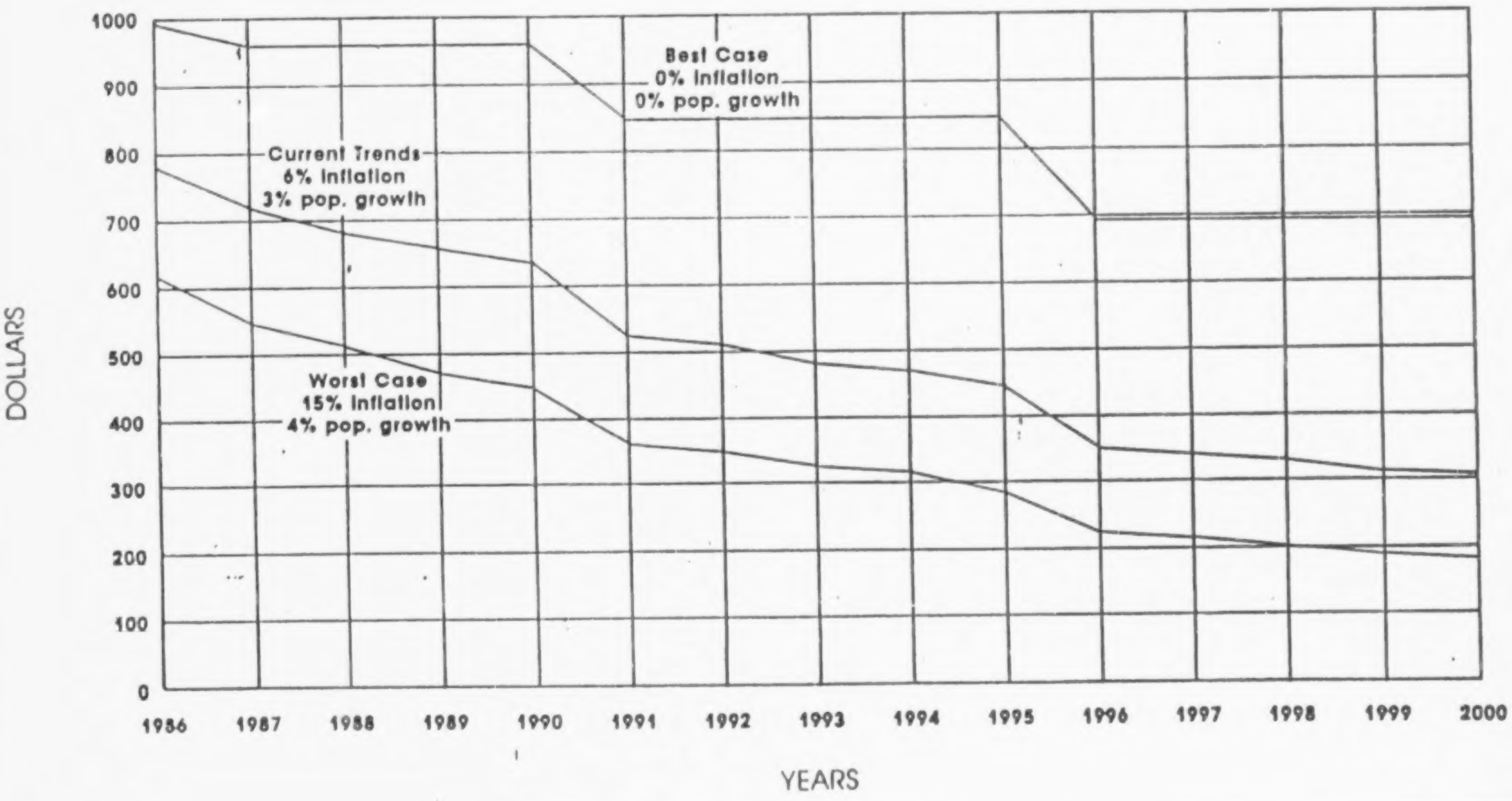


FIGURE 7

PROJECTED PER CAPITA U.S. AID UNDER THE COMPACT FOR PALAU, F.S.M., AND THE MARSHALLS

(Given current inflation and population trends; constant 1981 dollars)

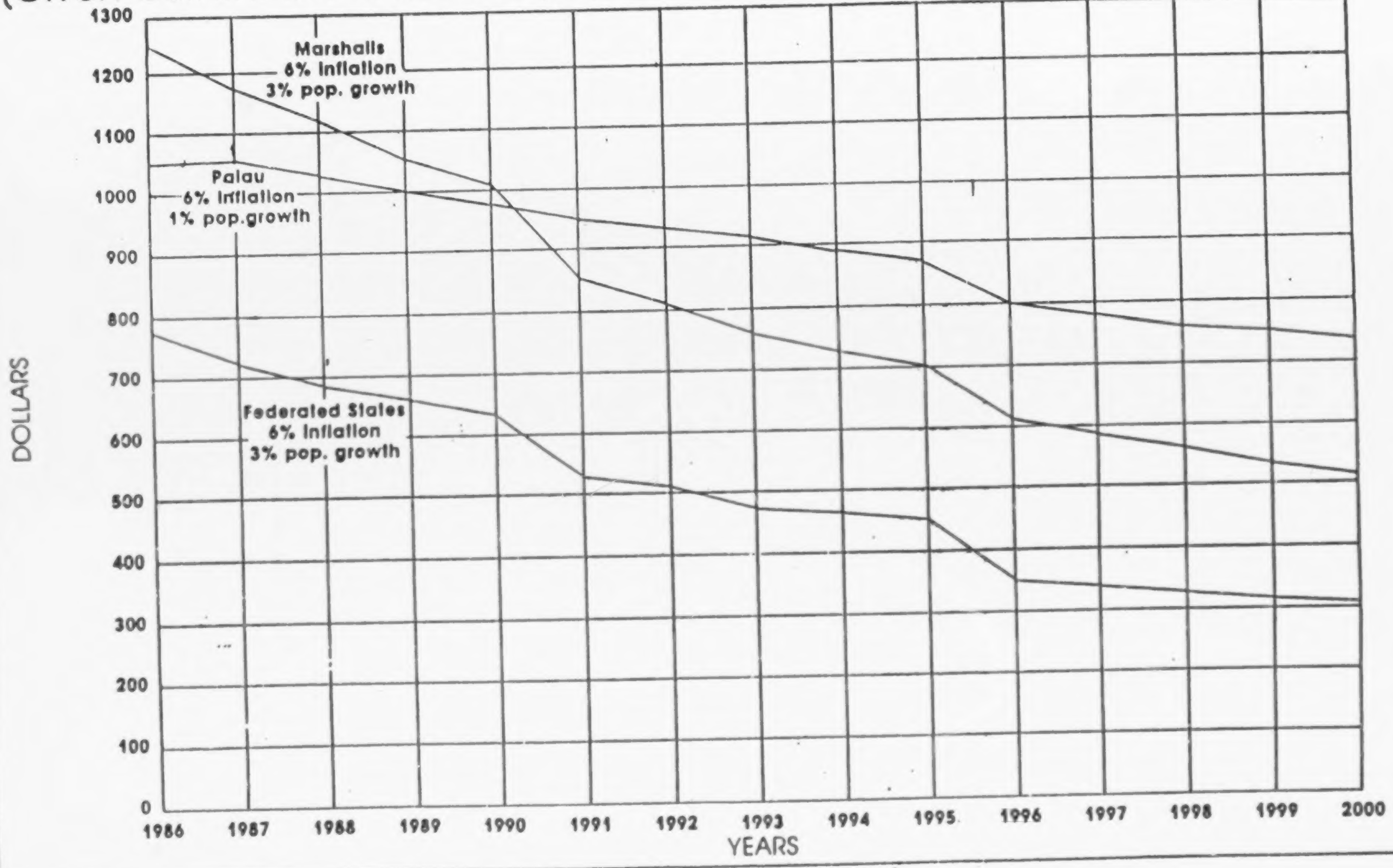


FIGURE 8

ADDITIONAL NEEDED INJECTIONS
TO KEEP CONSTANT PER CAPITA INCOME
(Given current inflation and population rates; constant 1981 million dollars)

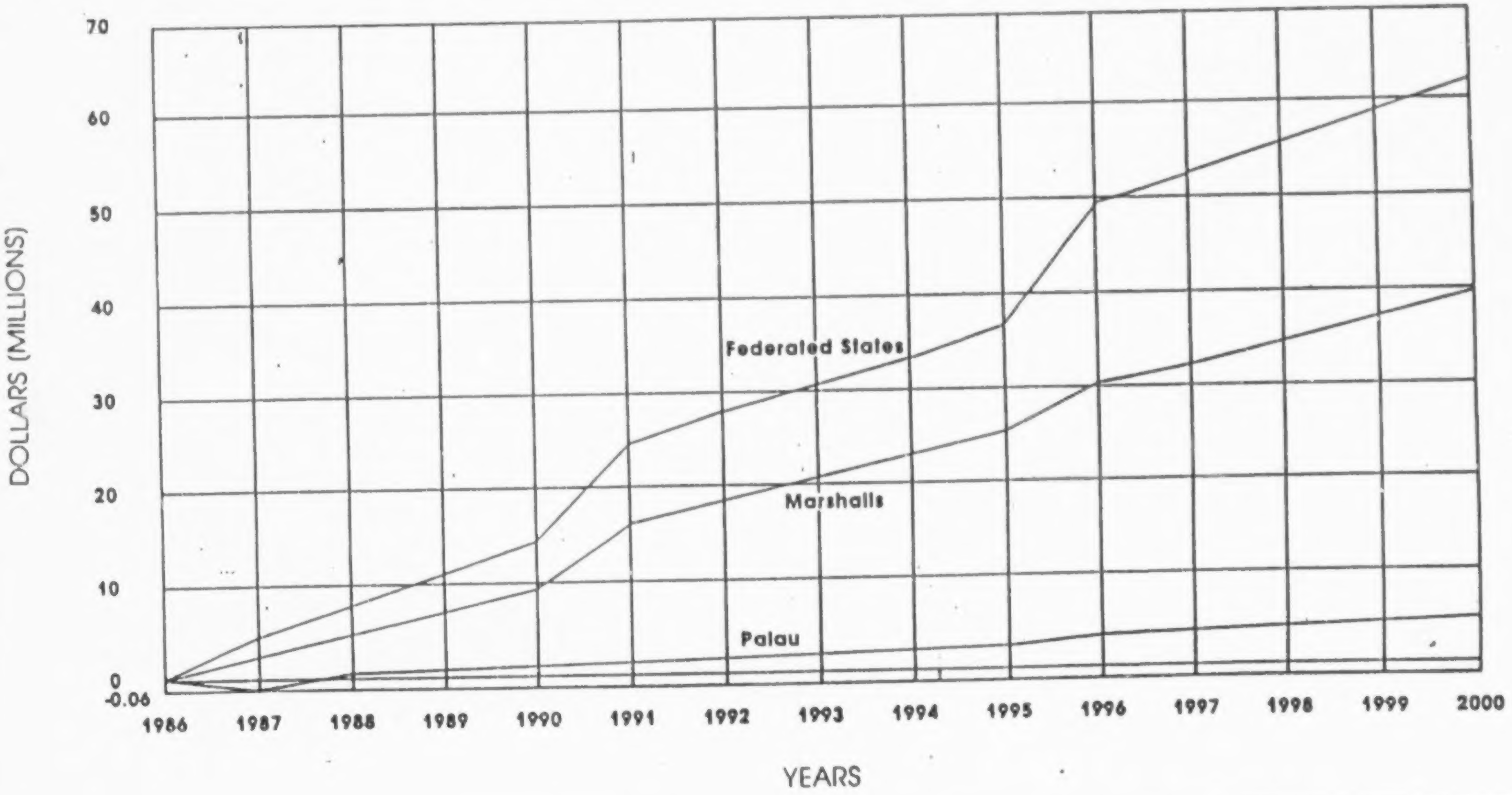


TABLE 1: PACIFIC BASIN PER CAPITA GNP COMPARISONS

United States	$11,360	Marshalls	$ 1,003
Japan	$ 9,890	Papua New Guinea	$ 780
Australia	$ 9,820	Philippines	$ 720
Guam	$ 7,010	Thailand	$ 670
Taiwan	$ 2,160	Tonga	$ 520
Fiji	$ 1,850	Solomon Islands	$ 460
Federated States	$ 1,301	Indonesia	$ 420

Note: all values are for 1980 except for the Marshalls (1981) and the Federated States (1983).

Source: Roger D. Hanson et al. US FOREIGN POLICY AND THE THIRD WORLD: AGENDA 1982. Washington, D.C.: Overseas Development Council, 1982, pp.160ff.; Republic of the Marshall Islands. FIRST FIVE YEAR DEVELOPMENT PLAN 1985-1989. Majuro: Nitijela Paper No.1, 1984. p.18; Federated States of Micronesia. FIRST NATIONAL DEVELOPMENT PLAN 1985-1989. Kolonia, Ponape: Office of Planning and Statistics, 1985, p.28.

TABLE 2: POPULATION DENSITIES (per square mile, 1980) LAND AREAS (square miles)

Island Area	Pop.	Land Area	Island Area	Pop.	Land Area
Palau Archipelago	64	190.6	All Marshalls	445	69
Kosrae Island	133	42.0	Truk Lagoon	738	49
Yap Proper	135	38.67	Majuro Atoll	3,360	3.54
Pohnpei Island	158	129.0	Ebeye Island	55,242	0.12

Source: U.S. Annual Report, 1980, 1984

TABLE 3: POPULATION (1820-1910)

Year	Palau		Federated States			Marshalls
		Yap	Truk	Pohnpei	Kosrae	
1820	-	-	-	15,000	-	-
1824	-	-	-	-	3,000	-
1844	-	-	-	8,000	1,700	-
1855	-	-	-	-	1,106	-
1862	10,000	-	-	-	-	-
1874	-	-	-	-	379	-
1877	-	-	12,000	5,000	-	-
1880	-	-	-	2,000	-	-
1882	4,000	-	-	-	-	-
1888	-	-	-	-	350	-
1891	-	-	-	1,705	-	-
1899	-	7,808	-	-	-	-
1900	3,750	-	-	3,165	-	-
1901	-	-	12,000	-	-	-
1903	-	7,156	-	-	-	15,000
1905	-	-	-	-	516	-
1908	4,321	-	-	-	-	-
1910	-	6,328	-	-	-	-

Source: O.W. Freeman, GEOGRAPHY OF THE PACIFIC (John Wiley & Son, Inc., New York, 1951), p.248; and the 1901 and 1903 German Reports.

TABLE 4: POPULATION (1920-1980)

Year	Palau		Federated States			Marshalls	Total
		Yap	Truk	Pohnpei	Kosrae		
1920	5,754	8,338	14,788	5,852	786	9,589	45,107
1925	5,957	7,366	14,961	6,713	886	9,422	45,305
1930	6,009	6,486	15,200	7,211	990	9,970	46,151
1935	6,230	5,741	15,129	7,764	1,189	9,967	46,282
1950	6,622	4,717	15,617	8,195	1,865	11,033	48,049
1955	7,656	5,102	17,334	10,300	2,235	13,260	55,887
1960	9,320	5,686	21,401	12,625	2,761	14,907	66,700
1965	10,832	6,438	25,820	15,607	3,351	18,062	80,110
1970	12,525	7,247	29,208	17,065	3,743	20,206	89,994
1973	12,673	7,870	31,609	19,263	3,989	25,045	100,449
1977	12,911	8,150	36,562	22,524	4,731	25,457	110,335
1980	12,173	8,172	37,383	22,367	5,522	31,045	116,662

Source: for 1920-1935; Japanese Government, Summary of Conditions in the Japanese Mandated Territories, 1935 (Nanyo Gunto Tosei Chosa-sho, Showa Ionen). 2 volumes. Tokyo:Nanyo-cho, 1937

TABLE 5: URBANIZATION (% of population living in towns)

	1955	1960	1965	1970	1973	1980
Palau	28.9%	39.5%	43.1%	45.3%	60.5%	62.9%
Marshalls	25.1%	34.7%	43.0%	56.5%	53.8%	59.7%
Truk	14.3%	14.1%	16.6%	17.3%	30.3%	27.5%
Pohnpei	8.9%	7.6%	10.7%	16.6%	24.9%	24.2%

Source: US Annual Reports.

TABLE 6: NON-MICRONESIAN POPULATION

Year	Palau	Federated States			Marshalls	Saipan
		Truk	Pohnpei & Kosrae	Yap		
1925	1,054	347	357	156	217	5,299
1930	2,078	749	689	241	422	15,656
1935	6,553	1,980	2,486	633	487	39,728
1984	472		609 (FSM TOTAL)		462	4,000

Source: Japanese Annual Reports and partial Trust Territory alien registration for 1984 as reported in Henry M. Schwalbenberg, S.J. "Micronesians on the Move: Guam or Hawaii?", reprinted in Hearing on General Law Provisions of the Proposed Compact of Free Association, before the Subcommittee on Public Lands and National Parks, 98th Congress, Second Session, 12 June 1984, 151.

TABLE 7: SUGAR PRODUCTION

Year	Sugar Cane Harvested (tons)	Sugar Produced (tons)	Export Value (yen)	Land Planted (acres)	Gov't Subsidy (yen)
1922	-	200	-	-	135,000
1923	38,000	1,400	-	-	95,000
1924	70,000	3,800	-	-	139,000
1925	125,000	9,800	-	6,800	131,000
1926	134,000	10,000	2,652,000	-	174,000
1927	207,000	13,300	4,393,000	-	236,000
1928	163,000	11,400	3,918,000	-	257,000
1929	147,000	10,800	3,250,000	-	515,000
1930	245,000	22,800	6,785,000	15,000	493,000
1931	405,000	42,400	9,237,000	-	531,000
1932	459,000	45,900	9,605,000	-	575,000
1933	452,000	48,200	12,913,000	-	479,000
1934	428,000	49,500	12,381,000	22,800	482,000
1935	597,000	74,900	18,134,000	-	485,000
1936	-	-	12,994,000	-	-
1937	-	85,600	19,565,000	28,300	-
1938	-	-	-	30,400	-
1939	-	-	-	-	-
1940	-	-	-	40,000	-

Sources: D. Purcell, 270-1; Yanaihara, 275; Japanese Annual Reports; and US Civil Affairs Handbook: Marianas, 148-166.

TABLE 8: ISLAND EXPORTS BY VALUE - 1937 (1000 yen)

	Marianas	Palau	Truk	Pohnpei	Marsh	Yap	Kosrae
Sugar	21,200	0	0	0	0	0	0
Starch	430	190	0	215	0	0	0
Other Crops	150	0	0	0	0	0	0
Phosphate	230	2,170	0	0	0	0	0
Dried Bonito	1,080	2,030	2,200	450	0	0	0
Shellfish	70	3,090	0	0	0	19	0
Copra	115	150	670	660	800	190	120
Rope	0	0	105	25	0	0	0
Misc	425	270	75	70	90	11	5
Total	23,700	7,900	3,050	1,420	220	125	890

Notes: in current 1984 prices the value of these exports are: sugar ($11.2 million); tuna or bonito ($2.74 million); and copra ($2.88 million).

Marshall figures are for 1936.

Source: US Civil Affairs Handbooks (1943 and 1944).

TABLE 9: JAPANESE BUDGET 1936 (1000 yen)

Activity	Subsidies	Salaries	Capital Formation	Other	Total	%
Admin	54	195	288	1,327	1,854	28.2%
Education	4	316	27	161	508	7.7%
Health	0	118	14	177	309	4.7%
Police	0	44	9	244	297	4.5%
Courts	0	50	1	20	71	1.1%
Comm & Trans	711	146	572	817	2,246	34.0%
Soil Research	0	16	35	90	141	2.1%
Industry	703	0	0	0	703	10.6%
Phspht Mining	0	18	8	314	340	5.1%
Electricity	0	4	26	94	124	1.9%
Total	1,472	907	980	3,244	6,603	100.0%
Percent	22.3%	13.7%	14.8%	49.2%	100%	

Note: for comparison purposes in 1975 the US Trust Territory budget allotted 24.6% for education and 15.2% for health. Also 60% of all US funding was for salaries and wages according the the UNDP Five Year Indicative Plan, 1976-1981, p. 26.

Source: Japanese Annual Report, 1937.

TABLE 10: INFLOWS OF PAYMENTS, 1917-1936 (million yen)

Year	Mandate Exports	Japanese Subsidy	Exports as a % of total inflow
1917	1.1	-	-
1918	1.8	-	-
1919	2.2	-	-
1920	2.2	-	-
1921	2.1	-	-
1922	1.8	3.0	37.5%
1923	2.3	3.0	43.4%
1924	3.5	2.8	55.6%
1925	5.9	1.8	76.6%
1926	6.8	1.8	79.1%
1927	7.9	1.8	81.4%
1928	8.6	1.8	82.7%
1929	7.6	1.5	83.5%
1930	10.6	1.0	91.4%
1931	12.8	0.5	96.2%
1932	13.9	0.0	100.0%
1933	18.7	0.0	100.0%
1934	18.4	0.0	100.0%
1935	26.4	0.0	100.0%
1936	25.0	0.0	100.0%
1937	37.3	0.0	100.0%

Source: Japanese Annual Reports for exports and Yanaihara for subsidy from the Imperial Treasury.

TABLE 11: INFLOWS OF PAYMENTS, EXPORTS 1947-1982 (million $)

Year	Exports	US Assistance	Exports as % of total inflows	Imports
1947	-	1.0	-	-
1948	2.4	1.0	70.6%	0.7
1949	2.1	1.1	65.6%	1.1
1950	1.6	0.8	66.7%	1.3
1951	2.2	1.0	68.8%	2.2
1952	1.8	4.3	29.5%	1.8
1953	1.2	5.2	18.8%	2.2
1954	3.3	4.3	43.4%	2.3
1955	4.3	5.0	46.2%	2.5
1956	1.7	5.0	46.2%	3.2
1957	1.6	4.8	25.0%	4.2
1958	1.7	6.2	21.5%	4.3
1959	1.2	4.9	19.7%	4.0
1960	1.9	5.2	26.8%	3.7
1961	2.1	5.9	26.3%	4.6
1962	2.1	6.1	25.6%	4.1
1963	2.2	17.0	11.5%	5.0
1964	2.7	18.0	13.0%	5.7
1965	3.2	21.5	13.0%	7.1
1966	3.6	21.9	14.1%	8.9
1967	2.3	25.2	8.4%	9.8
1968	3.0	26.3	10.2%	13.6
1969	2.9	36.2	7.4%	13.9
1970	4.2	54.6	7.1%	20.9
1971	3.0	67.3	4.3%	26.2
1972	2.6	68.1	3.7%	26.3
1973	1.9	69.4	2.7%	26.0
1974	8.0	69.5	10.3%	29.3
1975	6.8	81.7	7.7%	38.2
1976	4.8	100.9	4.5%	38.4
1977	10.3	114.2	8.3%	39.7
1978	-	132.6	-	38.3
1979	16.5	138.7	10.6%	38.4
1980	15.6	124.5	11.1%	-
1981	-	120.0	-	-
1982	8.1	119.9	6.3%	-

Sources: US Annual Reports for Exports and Imports; Draft Environmental Impact Statement for the Compact of Free Association for US Assistance.

TABLE 12: TRUST TERRITORY OPERATIONS BUDGET, 1975 ($ 000)

Activity	Actual Spending	Percent of Total
Judiciary	737	1.4%
Health Services	8,085	15.2%
Education	13,120	24.6%
Public Affairs	1,996	3.7%
Resources & Dvlpmnt	7,743	14.5%
Public Safety	2,349	4.4%
Administration	6,021	11.3%
Transport & Comm	3,718	7.0%
Public Works	9,475	17.8%
Total	53,244	100.0%

Note: For FY 1975 60% of expenditures was for salaries and wages, 23% for supplies, and 17% for travel, equipment, and other services. Operating costs in education showed the highest percentage for wages and salaries (78%), followed by Health (64%), Resources and Development (53%) and Transportation (29%).

Source: UNDP Five Year Indicative Plan 1076-1981, p.26.

TABLE 13: WAGE EMPLOYMENT, 1957-1979 (# of jobs)

Year	Federated States	Marshalls	Palau	Total
1957	1,571	742	718	3,031
1958	1,925	844	903	3,672
1959	1,760	733	775	3,268
1960	1,678	780	578	3,045
1961	1,608	783	641	3,032
1962	1,557	862	620	3,039
1963	1,961	1,725	786	4,472
1964	2,561	1,714	894	5,169
1965	2,909	1,940	1,381	6,230
1966	3,107	1,717	1,397	6,221
1967	3,173	1,775	1,353	6,301
1968	3,063	1,795	1,771	6,629
1969	3,265	2,018	1,627	6,910
1970	4,702	2,796	1,893	9,391
1971	5,558	2,777	2,266	10,601
1972	5,597	2,711	2,088	10,396
1973	6,108	2,889	2,213	11,210
1974	6,635	2,983	2,392	12,010
1975	7,499	3,200	2,551	13,250
1976	9,417	4,079	3,119	16,615
1977	10,752	4,245	3,227	18,224
1978	-	-	-	-
1979	11,578	3,977	3,228	18,783

Source: US Annual Report 1984, Statistical Section, Table 9

TABLE 14: TOTAL WAGE BILL, 1957-1979 (thousand US$)

Year	Federated States	Marshalls	Palau	Total
1957	667	501	373	1,541
1958	1,050	610	412	2,073
1959	1,064	583	402	2,049
1960	1,006	622	431	2,059
1961	962	695	535	2,192
1962	1,085	728	542	2,355
1963	1,314	1,419	624	3,357
1964	1,728	1,676	891	4,295
1965	2,461	1,723	980	5,164
1966	3,042	1,712	1,175	5,929
1967	2,931	2,498	1,284	6,713
1968	3,565	3,669	1,760	8,994
1969	4,630	3,926	2,033	10,589
1970	6,816	5,588	2,927	15,331
1971	7,941	6,145	3,458	17,544
1972	10,870	6,689	4,390	21,949
1973	12,799	7,582	5,114	25,495
1974	15,278	8,363	5,961	29,602
1975	17,774	9,395	6,644	33,813
1976	19,300	10,067	7,586	36,954
1977	21,236	10,943	7,723	42,781
1978	21,795	10,885	7,998	43,842
1979	25,267	12,053	8,437	41,547

Source: US Annual Report 1981, Statistical Section, Table 9

TABLE 15: US ASSISTANCE BY CATEGORY, 1947-82 (million US$)

Year	CIP	Federal Programs	DOI & other	Total
1947	0.0	0.0	1.0	1.0
1948	0.0	0.0	1.0	1.0
1949	0.0	0.0	1.1	1.1
1950	0.0	0.0	0.8	0.8
1951	0.0	0.0	1.0	1.0
1952	0.0	0.0	4.3	4.3
1953	0.0	0.0	5.2	5.2
1954	0.0	0.0	4.3	4.3
1955	0.0	0.0	5.0	5.0
1956	0.0	0.0	5.0	5.0
1957	0.0	0.0	4.8	4.8
1958	0.0	0.0	6.2	6.2
1959	0.0	0.0	4.9	4.9
1960	0.0	0.0	5.2	5.2
1961	0.0	0.0	5.9	5.9
1962	0.0	0.0	6.1	6.1
1963	0.0	2.0	15.0	17.0
1964	0.0	3.0	15.0	18.0
1965	0.0	4.0	17.5	21.5
1966	0.0	4.5	17.4	21.9
1967	0.0	6.0	19.2	25.2
1968	0.0	6.1	20.2	26.3
1969	7.6	6.2	22.4	36.2
1970	20.6	6.5	27.5	54.6
1971	25.3	7.4	34.6	67.3
1972	20.7	8.1	39.3	68.1
1973	16.3	9.4	43.7	69.4
1974	10.2	11.1	48.2	69.5
1975	14.8	11.9	55.0	81.7
1976	14.3*	11.5	75.1	100.9
1977	14.4*	25.1	74.7	114.2
1978	30.7	31.0	70.9	132.6
1979	54.3	24.1	60.3	138.7
1980	41.9	25.5	57.1	124.5
1981	20.7	25.5	73.8	120.0
1982	2.0	21.3	96.6	119.9

* US Annual Report for 1982 gives only a combined figure for 1976 and 1977. In the above table each year is assume to account for roughly half of the total.

Sources: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE COMPACT OF FREE ASSOCIATION, p.27 for Federal Program assistance and total US assistance; FIVE YEAR INDICATIVE DEVELOPMENT PLAN 1976-1981 gives expenditures for capital improvements for years 1969-1975; US ANNUAL REPORT 1982 gives expenditures for capital improvements for years 1976-1982; Department of Interior and other grants are calculated as the difference between total and CIP/Federal Programs.

TABLE 16: TOTAL CIP EXPENDITURE 1976-1982 (million US$)

Palau	$40.445	Pohnpei	$22.569
Yap	$30.165	Kosrae	$32.317
Truk	$35.040	Marshalls	$17.664
Total	$178.200		

Source: US Annual Report 1982.

TABLE 17: TOURIST INDUSTRY (Caroline and Marshall Islands)

Year	Visitors	Estimated Income
1968	3,000	$ 150,000
1969	4,476	$ 224,000
1970	7,310	$ 548,000
1971	11,272	$ 845,000
1972	11,835	$1,305,000
1973	17,396	$1,163,000
1974	15,511	$1,442,000
1975	19,227	$1,442,000
1976	17,713	$1,594,000
1977	22,260	$2,337,000
1978	23,111	$2,400,000
1979	27,311	$2,868,000

Breakdown of Visitor Entries for 1979: Total - 27,311

Palau - 5,891 Kosrae - 592 Truk - 6,110
Marshalls - 3,503 Pohnpei - 9,425 Yap - 1,790

Note: Estimated income based on average expenditure per visitor over a three day stay. The estimated average expenditure used is: $50 (1968-69); $75 (1970-75); $90 (19[illegible]6); and $105 (1977-79).

Source: US Annual Reports, especially 1980, appendix, p. 32.

TABLE 18: COMPARISON BETWEEN 1983 TRUSTEESHIP FUNDING WITH COMPACT FUNDING FOR 1983-84 INCLUDING INFLATION ADJUSTMENT PAYMENTS (million US$)

	Trusteeship	Compact	
	FY'83	FY'83	FY'84
A. Marshall Islands			
Current Operations	13.0	14.8	17.3
Federal Programs	4.9	2.9	1.4
Capital Improvements	2.9	12.5	8.8
KMR Tax Revenues	1.4	2.3	2.3
Total Gov't Funds	22.2	32.6	31.4
B. Federated States of Micronesia			
Current Operations	45.9	45.1	49.1
Federal Programs	12.9	7.0	7.0
Capital Improvements	20.0	36.4	28.6
Total Gov't Funds	78.8	88.5	84.7
C. Palau			
Current Operations	9.7	9.1	11.5
Federal Programs	2.4	2.0	2.0
Capital Improvements	6.7	8.8	6.7
Total Gov't Funds	18.8	19.9	20.2
D. Grand Totals			
Current Operations	68.6	69.0	77.9
Federal Programs	20.2	12.0	12.0
Capital Improvements	29.6	57.7	44.1
KMR Tax Revenues	1.4	2.3	2.3
Total Gov't Funds	119.8	141.0	136.3

Source: PAST ACHIEVEMENTS AND FUTURE POSSIBILITIES, p.73.

TABLE 19: PROJECTED PER CAPITA US AID FOR THE FEDERATED STATES UNDER THE COMPACT (constant 1981 dollars)

Year	Best Case 0% inflation 0% pop grwth	Current Trends 6% inflation 3% pop grwth	Worst Case 15% inflation 4% pop grwth
1986	996	779	613
1987	967	722	552
1988	967	691	514
1989	967	662	480
1990	967	635	450
1991	845	530	367
1992	845	509	346
1993	845	489	326
1994	845	470	308
1995	845	452	291
1996	697	355	224
1997	697	341	212
1998	697	329	201
1999	697	316	191
2000	697	305	182

Source: PAST ACHIEVEMENTS AND FUTURE POSSIBILITIES, p. 91.

TABLE 20: PROJECTED PER CAPITA US AID UNDER THE COMPACT FOR PALAU, THE FEDERATED STATES AND THE MARSHALLS GIVEN RECENT INFLATION AND POPULATION TRENDS (constant 1981 dollars)

Year	Palau 6% inflation 1% pop grwth	Federated States 6% inflation 3% pop grwth	Marshalls 6% inflation 3% pop grwth
1986	1050	779	1242
1987	1054	722	1175
1988	1027	691	1114
1989	1001	662	1058
1990	927	635	1005
1991	950	530	852
1992	929	509	810
1993	909	489	772
1994	890	470	736
1995	872	452	702
1996	799	355	618
1997	784	341	590
1998	769	329	564
1999	755	316	539
2000	741	305	516

Source: PAST ACHIEVEMENTS AND FUTURE POSSIBILITIES, p.91.

TABLE 21: ADDITIONAL NEEDED INCOME TO KEEP CONSTANT PER CAPITA INCOME LEVELS GIVEN RECENT INFLATION AND POPULATION RATES (constant 1981 million dollars)

Year	Palau	Federated States	Marshalls
1986	0.00	0.00	0.0
1987	-0.06	4.98	2.5
1988	0.32	7.97	4.9
1988	0.69	10.95	7.3
1990	1.03	13.93	9.6
1991	1.43	24.80	16.3
1992	1.75	27.75	18.6
1993	2.06	30.73	20.9
1994	2.36	33.74	23.2
1995	2.66	36.80	25.5
1996	3.79	49.18	30.3
1997	4.06	52.28	32.7
1998	4.33	55.45	35.0
1999	4.60	58.69	37.4
2000	4.86	62.00	39.8

Source: PAST ACHIEVEMENTS AND FUTURE POSSIBILITIES, p.94.

TABLE 22: TRUK'S CASH ECONOMY

A. MAJOR SOURCES OF INCOME (FY 1981)

Primary	
1. United States Assistance	
Department of Interior Grants	$10.5 million
Capital Infrastructure Program	9.5 million
US Federal Programs	5.3 million
Total	$25.3 million
2. Local Productive Economy	
Copra Exports	$ 0.6 million
Tourist Spending	0.8 million
Local Fishing	0.3 million
Total	$ 1.7 million
Secondary	
1. Service Sector (retail trade & services) Total	$25.2 million

B. GNP, POPULATION, AND PER CAPITA GNP

1. GNP	$52.2 million
2. POPULATION (1980)	37,383
3. PER CAPITA GNP	1,396

C. MAJOR SOURCES OF EMPLOYMENT (FY 1981)

1. Government Sector	2,000
2. Copra Producers (families)	1,600
3. Private Businesses	1,700

Source: Henry M. Schwalbenberg, S.J. "CIP Funding: For Economic Development or Political Consumption," MEMORANDA ON THE COMPACT OF FREE ASSOCITION. Truk: Micronesian Seminar, March 1982, table 2.

TABLE 23

Country	Assistance Received (Million $ U.S., 1982)	Population (Millions)	Per Capita Aid
Indonesia	1,522.6	159.2	$ 9.56
Malaysia	261.3	14.7	17.78
Philippines	634.0	51.9	12.21
Fiji	67.5	0.7	96.43
Kiribati	15.1	-	-
Papua New Guinea	450.1	3.3	136.39
Vanuatu	26.0	-	-
Western Samoa	22.7	0.2	113.5
Micronesia	119.9	0.136(1984)	881.62

Source: for Indonesia, Malaysia, Philippines, Fiji, Kiribati, Papua New Guinea, Vanuatu, and Western Samoa; United Nations, Economic and Social Survey of Asia and the Pacific 1984, Bangkok; 1985.

for Micronesia: OSM, 1984; U.S. Department of State, 1984.

Background Paper No. 6

FISCAL INCENTIVES, SOCIAL SUPPORT PROGRAMS, THE CARIBBEAN BASIN INITIATIVE AND THE DEVELOPMENT OF RENEWABLE RESOURCES IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS

(Authors' Draft)

by

Boris Oxman and Alan Udall

1986

Prepared for

U.S. Congress, Office of Technology Assessment,
Integrated Renewable Resource Management for U.S. Insular Areas,
Washington D.C.: U.S. Government Printing Office, 1987.

TABLE OF CONTENTS

LIST OF TABLES . . . .

ABSTRACT . . . .

I. INTRODUCTORY COMMENTS . . . .

- A. Historical Background . . . .
- B. Federal Programs . . . .
- C. Some Data Limitations . . . .
- D. Organization . . . .

Section 1: Current Situation and Federal Incentives

II. INCENTIVE PROGRAMS AFFECTING PRODUCTION . . . .

- A. Introduction . . . .
- B. Agriculture . . . .
- C. Fisheries . . . .
- D. Forestry . . . .

III. INCENTIVE PROGRAMS AFFECTING RESOURCE CONSERVATION .

- A. Introduction . . . .
- B. Soils . . . .
- C. Water . . . .

Section 2: Special Federal Programs

IV. U.S. SOCIAL SUPPORT PROGRAMS AND RENEWABLE RESOURCES

- A. The Growth of Social Support Programs . . . .
- B. Special Needs for Social Support Programs . . . .
- C. Population - Resource Balance . . . .
- D. Incentives for Work and Production . . . .

V. SECTIONS 934 AND 936 RELATED TO RENEWABLE RESOURCE DEVELOPMENT . . . .

- A. Introduciton . . . .
- B. Incentives for Manufacturing Investment . . . . .
- C. Industrialization and the Local Resource Base . .
- D. Credit Programs . . . .

TABLE OF CONTENTS (CONTINUED)

VI. TRADE POLICY AND THE CARIBBEAN BASIN INITIATIVE RELATED TO RENEWABLE RESOURCE DEVELOPMENT . . . . . .

  A. Introduction . . . .
  B. Definition and Explanation of the CBI . . . .
  C. Effects on Renewable Resource Industries . . . . .
  D. Other Aspects of U.S. Trade Policy . . . .

VII. SUMMARY AND POSSIBLE CHANGES IN U.S. POLICY . . . .

LIST OF ACRONYMS . . . .

FOOTNOTES . . . .

BIBLIOGRAPHY . . . .

List of Tables

Table 1: Historic Summary of Federal Expenditures . . .

Table 2: Federal Expenditures for Development Incentives . . . .

Table 3: Federal Expenditures for Social Support Activities . . . .

Table 4: Employment by Sector . . . .

Table 5: Employment in Agriculture . . . .

Table 6: Trends in Agricultural Structure . . . .

Table 7: Changes in Agricultural Infrastructure . . . .

Table 8: Index of Physical Volume of Agricultural Production . . . .

Table 9: Gross Farm Income at Current Prices . . . . . .

Table 10: Characteristics of Farm Operators . . . .

Table 12: Fisheries Data . . . .

Table 13: Federal Social Support Programs in Puerto Rico . . . .

Table 14: Transfers between Puerto Rico, Federal Government, State Governments, and Other Non-Residents . . . .

Table 15: Urban/Rural Population . . . .

Table 16: Birth and Death Rates . . . .

Table 17: Population Change . . . .

Table 18: Basic Elements of Population Change . . . . . .

Table 19: Labor Force and Employment . . . .

Table 20: Primary Sources of Foodstuffs Consumed in Puerto Rico . . . .

List of Tables (continued)

Table 21: Employment and Compensation in 936 Industries Related to Renewable Resources . . . . . .

Table 22: Employment by Sector 1940-1984: Puerto Rico . .

Table 23: CBI Beneficiary Countries . . . .

Table 24: Basic Information about CBI Beneficiary Countries . . . .

Table 25: Shipments of Processed Renewable Resource Products from Puerto Rico . . . .

ABSTRACT

The Federal government has intervened in an all - pervasive way in matters regarding natural resource use in Puerto Rico and the Virgin Islands. In this study we have taken a broad view of the term "incentives" -- especially since Puerto Rico has an independent tax system -- and have described a large number of different programs. The programs are wide ranging, including not only technical assistance but also regulation and control, as well as construction subsidies. U.S. trade policy also affects the island territories.

Regarding Social Support programs in particular, we found that the programs in these areas had increased very rapidly and were relatively large compared to the size of the local economies. There are also special circumstances which have created a genuine need for these programs. They have positively affected resource conservation by reducing the strain which a dense population places on local ecosystems. Food and fuel can be imported and do not have to be squeezed out of the local soil and water system. And there is no hard economic evidence that they have damaged work incentives. On the other hand, they have led to a higher unemployment rate than would otherwise have prevailed.

Regarding Section 934 and 936, these incentives have had a large and all-pervasive effect in economic development -- especially in Puerto Rico, which is oriented more towards manufacturing and less towards tourism than the Virgin Islands. However, the effects of the programs -- particularly subsidized credit -- in fostering the development of natural resource based industries has been minor, though this is changing.

The effect of the CBI has been small in both Puerto Rico and the Virgin Islands, compared with other aspects of U.S. trade policy such as opening up American markets to the exports of developing countries. The ability to create free ports has been crucial to the development of the U.S. Virgin Islands. But the CBI "twin plant" program has not grown large yet, and only a very small number of the proposed projects involve natural resource based industries. Generally, those that do involve these industries would process Caribbean natural resources in Puerto Rico for shipment to the U.S. market.

Generally, these different interventions have followed trends in overall domestic policy, have not been coordinated well with one another, and have not always been sufficiently flexible to take into account the special circumstances of the island territories.

CHAPTER I: INTRODUCTORY COMMENTS

Puerto Rico and the United States Virgin Islands are two island dependencies of the United States, located in the chain of semi-tropical islands that stretch from the Yucatan Peninsula of Mexico to the northeasterly corner of South America, separating the Caribbean Sea from the Gulf of Mexico and the Atlantic Ocean. They enjoy a mild climate, affected by the easterly trade winds, but are occasionally severely affected by tropical storms and hurricanes. Both jurisdictions are situated near the edge of the Caribbean Plate, at a point where that tectonic plate encounters the North Atlantic Plate. As a result, they are in an area that has been described as the third most active seismic area of the United States (after Alaska and California), and may be affected by a major earthquake event before the end of this century, if past history is a reliable guide.

A. Historical Background

The islands were claimed by European powers after their discovery by Columbus in 1492, and were subsequently settled and exploited for the benefit of various countries. In both Puerto Rico and the Virgin Islands, the historic record indicates that prior to their "discovery" and settlement by Europeans, the islands were heavily forested. Under the arrogant assertion of the "divine right" of kings, the lands in the colonies were handed over to individuals or groups to be administered more or less for the benefit of the monarch. Over time, the forest cover was removed from the coastal plains, as well as from some of the hills, to open up land for agriculture, and they became more exposed to the weather.[1] While the islands were colonies of European powers, and the colonial mercantile system was in full effect, they had agricultural economies.[2] They were never completely self-sufficient, and imported manufactured goods and other necessities from the home country. Sugar cane was at one time the principal crop in the agricultural sector, and was the major employer of local labor. Coffee and tobacco also became major commodities in internal as well as international trade.

Puerto Rico was under the dominion of Spain until it was ceded to the United States in 1899 under the Treaty of Paris which ended the Spanish-American War. The Virgin Islands came under Danish rule, and were purchased from Denmark by the United States in 1917. Both were characterized as agrarian societies, and remained so until after World War II. However, as we shall see in the following sections, the role of agriculture has declined substantially in the postwar period.

Under the Territories clause of the Constitution, Congress has enacted various organic laws related to the administration of each of the two jurisdictions, taking into account their individual circumstances and needs. The special fiscal arrangements are discussed below in this document. Both were administered initially by American military agencies under governors who were appointed by the President. In 1931 President

Introduction

Herbert Hoover transferred responsibility for the Virgin Islands from the Navy to the Department of the Interior; President Franklin Roosevelt transferred Puerto Rico from the Army to Interior in 1935. Congress provided for an elected governor in Puerto Rico in 1940, and in the Virgin Islands in 1968. Puerto Rico became a Commonwealth in 1952 under a procedure authorized by Congress in 1950.

Although constitutional conventions have been convened in the Virgin Islands, it has not been feasible to obtain consensus with regard to their results, and that territory continues to be administered by Interior. As a consequence of various actions by Congress, over time, persons born in Puerto Rico and the Virgin Islands are full citizens of the United States, and their travel between the islands and the mainland is unrestricted. Their voting rights are subject only to the requirements of the state in which they reside at the time of an election. Neither Puerto Rico nor the Virgin Islands participates in presidential elections, nor are they fully represented in Congress. Puerto Rico has a Resident Commissioner, and the Virgin Islands has a Delegate, each of whom is elected for four years and is provided with office space and staff by the House of Representatives. They may serve on Committees of the House and may vote in those committees, but they may not vote on the floor of the House.

Introduction

When enacting legislation, Congress may provide for the inclusion or the exclusion of the territories. Because of its size, Puerto Rico is generally (but not always) treated as a state, but the Virgin Islands are provided for generally in provisions that apply to all the territories. The instances in which special treatment is accorded to them are discussed later.

As of 1985, the population of Puerto Rico is estimated to be 3.4 million persons, while that of the Virgin Islands is estimated at 102 thousand. The land area of Puerto Rico is 3,435 square miles, and that of the Virgin Islands totals 132 square miles. Thus, the population density of Puerto Rico is about 990 persons per square mile (about equal to that of New Jersey, the most densely populated state), and that of the Virgin Islands is about 770 persons per square mile (about equal to Connecticut, the second most densely populated state).[3] These densities rank among the highest in the world. The foregoing factors affect the demand for renewable resources in the islands, and their ability to satisfy those demands through local production and trade.

B. Federal Programs

At one time or another, the Congress has established public policies or programs related to energy, soil and water, and to many of the activities that relate to various kinds of renewable resources. However, Federal legislation and programs designed to meet specific problems or situations related to renewable resources of the mainland states are not always appropriate or effective in the islands of the tropics, whether in the Caribbean Sea or the Pacific Ocean. Furthermore, there may exist special circumstances which make necessary greater efforts in social support and special incentives to establish industry.

With relatively few important exceptions, Puerto Rico and the Virgin Islands participate in the full gamut of Federal incentive and social support programs. Table 1, page 10, summarizes the Federal funds expended in the two jurisdictions during Fiscal Years 1981, 1982, 1983, and 1984. Tables 2 and 3, on the following pages, show the major Federal programs that are current, and the amounts that have been assigned to Puerto Rico and the Virgin Islands during the past two fiscal years. Table 2, on page 11, shows Federal fiscal incentives related in some way to renewable resources. Table 3, on page 12, details social support programs. The abbreviations in the tables are defined in a special list of acronyms at the end of this report.

Some programs involve payments directly by a Federal agency to individuals, producers or consumers, while others function through a state-level intermediary. Published records are available to indicate the comparative performance or success of some programs. Some programs change over time, and have left no records. Other programs are covered by special conditions in legislation that applies to other situations as well; the myriad individual decisions affected by such provisions are not feasible to identify.

It is also important to note that the tables may not be complete, inasmuch as the Federal reports from which they were compiled vary from year to year in the way that the programs are presented. When programs are aggregated into "Other" columns, the national total may be available, but not the distribution among the various states and territories. Further, since certain incentive programs are provided in statutes related to individual or corporate income tax returns (e.g., Section 936), no Federal outlays are involved and the programs are not included in the reports.

C. Some Data Limitations

In assembling material for this report, the primary resource was the Document Room of the Main Library of the University of Puerto Rico at Rio Piedras. That is the Depository Library for all Federal official publications that relate to Puerto Rico. Within the time limits imposed for the preparation of this report, it was not feasible to obtain the similar Federal documents for the Virgin Islands by inter-library loan. The Caribbean Regional Collection of the UPR library provided materials for the Virgin Islands, but it is not a Depositary Library, and the materials are not always up to date. The libraries of the Puerto Rico Planning Board, the Economic Development Administration, and the Department of Natural Resources, and their respective staffs, also provided useful guidance and assistance.

Introduction

The national accounts and data reporting systems of the Commonwealth of Puerto Rico do not have any equals in the region. In most instances, information at similar levels of detail does not exist for the Virgin Islands. The information contained in the various tables is derived primarily from Puerto Rican data. Where similar information is available for the Virgin Islands, it is presented in the same form.

D. Organization

We have departed somewhat from the organization originally requested by the OTA, because it does not fit the realities of the relationship between the Federal government and the Caribbean Territories. One of these realities is that the traditional economists' term "tax and trade incentives" is not really useful for understanding Federal programs in the region. Since Puerto Rico has an independent tax system, Federal tax incentives there have limited scope, except for Section 936 of the Internal Revenue Code, which is considered in a separate chapter.

By Federal law, the Virgin Islands are required to follow Federal tax laws for much of their own tax system. Likewise, since most of the trade of the Caribbean Territories is with the U.S. mainland, there are few trade incentives directed specifically toward the islands. Although general U.S. trade policy may well have affected Puerto Rico and the Virgin Islands in important ways, little research has been done to untangle these effects from other historical trends, and there is not too much that can be usefully said on the subject given our present state of knowledge.

A second reality is that Federal programs in Puerto Rico and the Virgin Islands are very large relative to the size of the local economies. Thus, there is a massive array of Federal programs which are really "incentives" of one sort or another, but which do not fall under the traditional economists' understanding of the term. We take an inventory of some of the most important of these in the first part of the study. But because we believed that the originators of this study did not fully appreciate the variety of incentives offered, we have greatly exceeded our space limitations. Even so, we have been able to discuss the various programs only in the most general terms, with a few specific examples where appropriate.

The study will be organized as follows. Section I reviews Federal incentives as we believe the term should be interpreted for these Caribbean islands. Chapter I deals with incentives involving resource-based economic activity: agriculture, fishing, and forestry. Chapter II discusses incentives involving the conservation and rational exploitation of the soil and water resources themselves. In the second section, we discuss specific programs which were requested as part of the study: Section 936, social support programs, and the CBI. Each of these has a separate chapter. Finally, the concluding section summarizes the material and makes some general recommendations for Federal policy changes.

Introduction

The most important general pattern which one can draw out of this description of special programs is that the Federal government does intervene very strongly in natural resource policies of Puerto Rico and the Virgin Islands, but that it does not plan or coordinate these programs with sufficient vision, or with a sufficiently long term perspective. There is a lack of flexibility to deal with the special needs of the islands due to their particular climate, resource base, and environmental problems. There is now general agreement among Territorial experts that the Federal Government needs to reform the way in which it makes policy toward the Territories.[4]

Table 1

HISTORIC SUMMARY OF FEDERAL EXPENDITURES
By Major Activity, Fiscal Years 1981-84
(Total U.S., Puerto Rico, Virgin Islands)
(Millions of current dollars)

Area	Year	Total Expended	Grants to State & Local	Federal Salaries	Payments to Ind.	Procurement	Other
US Total:	1981	562219	94806	74169	259653	128188	5402
	1982	603683	88221	78043	286187	145816	5415
	1983	694568	92693	102597	319816	158929	20533
	1984	724749	97209	108653	325881	176470	16536
Pto Rico:	1981	4110	1352	234	2298	221	4
	1982	4617	1397	252	2708	255	5
	1983	4746	2111	349	2264	8	14
	1984	5403	2231	359	2354	431	28
Virgin I:	1981	570	154	10	56	351	0
	1982	280	116	11	56	96	0
	1983	177	91	18	67	0	1
	1984	407	137	30	73	165	2

Source: US Dept of Commerce, Bureau of the Census:
Federal Expenditures by State, FY 1984

Table 2

FEDERAL EXPENDITURES FOR DEVELOPMENT INCENTIVES
($000,000)

Program Identity	Puerto Rico FY 1982	FY 1983	FY 1984	Virgin Islands FY 1982	FY 1983	FY 1984
GRANTS TO STATE AND LOCAL GOVERNMENT						
Ag-AMS-MarketImp		.6	1.1		0	0
Ag-CCC-PriceSupport	16.7	33.7	6.7	.8	1.4	1.3
Ag-CSRS-AgExpSta	3.5	3.6	2.9	0	.2	.5
Ag-ExtensionSvc	6.5	6.5	5.1	.2	.7	.4
Ag-FmHA-RuralWtr/WasteDisp	3.5	2.5	5.9	0	0	0
Ag-FS-State/PvtForestry	.2	.2	.2	0		
Ad-SCS-WatershedProtection	.7	.1	.2	0	0	0
Agriculture, Subtotal	31.1	47.2	22.1	.2	2.3	2.2
Com-EDA-EcDevAssist	7.6	3.4	5.6	3.6	.4	1
Com-NOAA-CZM/NMFS	1.9	1.6	.6	.6	.6	.2
Commerce, Subtotal	9.5	5	6.2	4.2	1	1.2
HUD-UDAG,etc., Subtotal	5.5	7.6	0	0	0	0
Int - Fish & Wildlife Svc	1	.7	.6	.4	.2	.3
Int - National Park Svc	2.9	2	3	.8	.2	
Int - Territories Office	0	0	0	56	35	33
Interior, Subtotal	3	2.7	3.6	57.2	35.4	33.3
SBA-Park,RecArea Dev		1	0		0	0
DOT-FHwA-HwayTrustFd,etc	21.4	24	30.3		2.2	0
TOTAL GRANTS PROGRAMS	70.5	84.8	62.2	61.6	40.9	36.7
BUSINESS LOANS AND INSURANCE PROGRAMS						
Ag - Commodity Loans	.7	.4	.1	0	0	0
SBA - Business Dev Loans	17.9	2.8	.5	.8	.8	.3
Other Loans		23	7.6		2.3	3.4
Loans-Subtotal	18.6	26.2	8.2	0	3.1	3.7
Ag - Farm Loan Guarantees	18.4	10	21.4		0	.2
SBA - Guaranteed Loans		10.4	12.3		.5	2.2
Ag-REA-Rural Elec/Tel Loans		56.8	45.8		0	0
Other	2.3	91.1	49.1		1.7	3.8
TOTAL LOANS AND GUARANTEES	20.7	168.3	128.6	.9	2.2	6.2
TOTAL DEVELOPMENT INCENTIVE	91.2	253.1	190.8	62.5	43.1	42.9

Source: US Dept of Commerce, Bureau of the Census:
Federal Expenditures by State for FY 1982, FY 1983 and FY 1984

Table 3

FEDERAL EXPENDITURES FOR SOCIAL SUPPORT ACTIVITIES
($000,000)

	Puerto Rico			Virgin Islands		
	1982	1983	1984	1982	1983	1984
DIRECT PAYMENTS TO INDIVIDUALS						
Total in Report	2714.9	2774.9	2354.3	56.5	66.8	73.2
Interest on Student Loans		9.2	13.5	.6	.6	1.1
Pell Grants	135.5	178.1	195.1	.3	.5	.5
Student Aid-Total	135.5	187.3	208.6	.9	1.1	1.6
LowIncomeHousingPayments	2	49.7	58	.5	2.7	5.5
Railroad Workers Insurance	.9	1	1	.1	.1	.1
FedUnemplCompensation	18.9	22	11.5		1.9	1.4
Medicare-Hospital	107.7	110.2	113.3	0	0	0
Medicare-SupplementMedical	63.9	70.1	72.9	0	0	0
Medicare-Total	171.6	180.3	186.2	0	0	0
Social Security Disability	442	455.7	457	2.8	3	3.1
Social Security Retirement	622.8	700.1	747	17.3	19.8	21.9
Social Security - Survivors	291.3	290.7	303.5	7.2	7.2	7.5
Social Security - Total	1356.1	1446.5	1507.5	27.3	30	32.5
VA - Service Disability	129.8	126.7	125	1.2	.5	.5
VA - Death Benefits	12.4	11.4	11.6	.2	.1	.1
VA - Non-service Disability	61.8	59.7	59.9	.3	.1	.1
VA - Survivor Benefits	22.7	20.7	21.3	.1	.1	.1
VA - Education Benefits	10.9	11.4	9.6	.1	.1	.1
Veterans Admin - Total	237.6	229.9	227.4	1.9	.9	.9
FedWorkerCompensation	4.9	5.2	6	.1	.1	.1
Fed Retirement - Military	43.4	45.4	45.2	2.5	2.7	2.8
Fed Retirement - Civil	62.4	66.5	70.2	3.2	3.8	4.1
Federal Retirement - Total	105.8	111.9	115.4	5.7	6.5	6.9
FoodStamps	671.2	See Note	See Note	19.8	23.4	24.1
All Other	10.1	40.9	32.5		.1	.1
TOTAL DIRECT PAYMENTS	1805.8	2274.7	2354.1	36.5	66.8	73.2

Table 3 - Federal Expenditures for Social Support Activities (continued) page 2

GRANTS TO STATE/LOCAL GOVT FOR SOCIAL PROGRAMS

Ag-FNS-ChildNutrition	93.5	100.9	120.5	3.8	4.5	3.4
Ag-FNS-FoodDonations	.7	.7	1.9	.1	.1	.1
Ag-FNS-FoodStampBlockGrant	226.8	814.7	814	.1	.9	1
Ag-FNS-WIC	23.6	29.4	54	1.5	2.9	4.5
Ag-Food&Nutrition Svc Total	344.6	945.7	990.4	5.5	8.4	9
Ed-ESE-Disadvantaged	.7	31.9	44.1	.4	.5	0
Ed-ESE-General	44.3	0	0	3.2	1.2	.3
Ed-ESE-Libraries	3.8	1.7	.8	.1	.1	0
Ed-ESE-FedAffectedAreaAsst	6.7	6.8	.7	.5	.5	0
Ed-PostSec-StudentAid	.6	1.6	1.4			0
Ed-SER-Handicapped	2.2	2.1	1.5	1.4	1.4	.9
Ed-SER-Rehabilitation	18.4	20.4	16.7	.2	.8	18.9
Ed-Voc/Adult	8.9	9	10.7	.3	.3	.3
Education - Total al	85.6	73.5	75.9	6.1	4.8	20.4
Environ.Prot.Agency Total	54	21.8	18.5	.8	1.2	.6
Fed.EmergencyMgtAgency Tot	4.4	3.8	3		.5	1.4
HHS-Alcohol,Drug, Mental	4.4	5.9	6.3	.5	.8	.8
HHS-CDC-DiseaseControl	2.5	2.7	3.9	.1	.2	.3
HHS-Medicaid	48.7	42.9	43.9	1.4	1.4	2.4
HHS-HlthResSvcAdm	.9	33.9	27		3.1	2.8
HHS-Health Subtotal	56.5	85.4	81.1	2	5.5	6.3
HHS-HDS-CommunitySvc	10.2	7.3	7.7	.3	.5	.5
HHS-HDS-FamilySvc		4	6.5		0	0
HHS-HDS-HumanDevSvc	35.6	48.8	51.9	3.3	3.3	3.5
HHS-HDS-SocSvcBlockGrant	28.2	17.2	19.1	1.4	.5	.5
HHS-HDS-WorkIncentives	1.5	.9	1.7	.2	.1	.4
HHS-HumanDevSvc Subtotal	75.5	78.2	86.9	5.2	4.4	4.9
HHS-SSA-AFDC	64.7	76.6	72	2.7	2.4	2.2
HHS-SSA-ChildSupEnforcemt	1.9	2.2	3.2	.2	.2	.2
HHS-SSA-LowIncomeEnergy	2.2	2.3	2.4	.1	.1	.1
HHS-SSA-RefugeeAssist	0	0	0	0	0	0
HHS-SocialSvc Subtotal	68.8	81.1	77.6	3	2.4	2.5
Health & Human Svc Total	200.8	244.7	245.6	10.2	12.3	13.7

Table 3 - Federal Expenditures for Social Support Activities (continued) page 3

HUD-CommunityDev	94	95.1	122.1	.7	1.6	1.7
HUD-LowRentPublicHsg	86.2	118.2	129.2	9.2	12.4	41.2
HUD-Other	6.5	7.7	0	0	0	0
Housing&UrbanDev Total	186.7	221	251.3	9.9	14	42.9
Labor-ETA-OlderAmEmpl	0	0	0	.4	.6	.9
Labor-ETA-StateUnempInsEtc	15.1	18.2	18.9	2.1	2.7	2.5
Labor-ETA-TempEmp	1.7	1.3				
Labor-ETA-TrngEmpSvc/JobTng	87.9	80.2	79.7	2.6	2.5	2.1
Labor-OSHA	.9	1.7	1.1	.1	.2	.1
Labor-Subtotal	105.6	101.4	99.7	5.2	6	5.6
DOT-UMTA	13.7	23.7	13.1		.9	.1
AGGREGATE GRANTS	995.4	1635.6	1697.5	37.7	48.1	93.7
FEDERAL LOAN AND INSURANCE	PROGRAMS					
FmHARuralHousing	76.8			3.9		
Low/ModIncRent/CoopMtgIns	55.2					
Low-incHsgRepairLoans		.2			0	
HomeMortgageInsuredLoans	84.2	68.5	106.2	.1	.5	.1
Property Imp Loan Ins	20.9	12.7	22.7			
VA Home Loans	2.9	2.5	3.7			.2
GuaranteedStudentLoans	13.6	41.6	73.3	1.9	2.2	117.4
Disaster Repair Loans	2.1					
TOTAL LOANS/INSURANCE	255.7	125.5	205.9	5.9	2.7	118.6
TOTAL SOCIAL SUPPORT	3056.9	4035.8	4257.5	80.1	117.6	285.5

Note: PR Food Stamp Program converted to block grant
Blank space indicates value less than $50,000
Zero indicates no funds reported

Source: US Dept of Commerce, Bureau of Census:
Federal Expenditures by States for FY 1982, FY 1983 and FY 1984

SECTION 1: CURRRENT SITUATION AND FEDERAL INCENTIVES

CHAPTER II: INCENTIVE PROGRAMS AFFECTING PRODUCTION

A. Introduction

The development of renewable resources may be divided into several categories for purposes of analysis and discussion. The first category is energy, upon which all the other resources depend to one degree or another. The second category includes soil and water, which combine with energy to propagate animal and plant life. These will be discussed in the following chapter. Renewable resources produced for economic gain, in which the producer exercises control over the various stages of planting, cultivating, harvesting, and marketing, include such activities as agriculture, animal husbandry, aquaculture, and forestry. Activities in which the producer must depend more directly upon the vagaries of nature include fishing and hunting.

In this chapter we will consider all of these types of activities. They depend, of course, upon individual decisions by human beings, who, for the purposes of this study, may be considered as another kind of renewable resource. Human resources will be considered in a later chapter, as related to social support programs.

B. Agriculture

During the past three decades, the economic structure of each island has been transformed, and agriculture's role is now vastly reduced. In this section we will discuss three major changes: the shift in types of crops and markets, changes in the economic impact of natural disasters, and long-term shifts in the structure of the labor force. All of these changes are due in some degree to shifts in Federal incentive programs.

i. Changes in Products and Markets

Agriculture is oriented toward very different markets now than it was during the 1930's. We are informed, for instance, in the Chardon Report of 1934, that by 1928 Puerto Rico had some 8,000 acres of citrus in production, with another 4,000 acres about to bear fruit. One million boxes of fruit had been shipped to the U.S. market, and the prospects for expansion appeared unlimited. Thousands of acres were planted in high quality Sea Island cotton, in addition to the traditional three main crops of sugarcane, coffee and tobacco.[5]

At the present time, of these crops only coffee is still cultivated in large amounts. This is due to a special local excise tax which Puerto Rico was permitted to levy on coffee produced off the island. It is the only product which the island government has been permitted to protect from outside competition through locally-controlled import duties.[6] As a result, as labor costs have risen relative to other areas, the island government has continued raising the tax to preserve a cost advantage for local producers. Thus, the island is self-sufficient in coffee, but consumer prices for that product are substantially higher than in surrounding countries or on the U.S. mainland.

Production Incentives

Of the other major products mentioned in the Chardon Report only sugar is still grown on the islands. It formed a major component of both economies, even in the early postwar period and its decline helps to explain the chronic unemployment problem which still remains in the islands. Sugar is now grown only in small amounts and is heavily subsidized by the local government to preserve the few thousand jobs remaining in the industry. This change is largely due to rapid increases in labor costs on the islands, resulting from the imposition of the Federal minimum wage, the rapid growth in the demand for manufacturing labor in the 1950's, and improved access to relatively high wage jobs on the mainland. Likewise, technical progress in island sugar production lagged behind that in Hawaii and on the U.S. mainland.[7]

Like the other Caribbean islands, Puerto Rico and the Virgin Islands have lost much of their mainland sugar markets, due to the U.S. policy of maintaining artificially high prices, discouraging mainland consumption and stimulating the development of substitute artificial sweeteners. This is true despite the fact that Puerto Rico and the Virgin Islands are not subject to the sugar quotas imposed on other Caribbean islands which are independent countries.[8]

Although encouraged by Federal experts in the 1930's, cotton was never an economic success in Puerto Rico and the Virgin Islands, and its cultivation never was an important factor in the overall economy. Likewise, citrus never developed much either.

With a few minor exceptions citrus crops are grown only in small amounts for local consumption, and the islands even import substantial amounts of citrus crops.

ii. Natural Disasters

In September of 1928, in September of 1930, and again in September 1932, Puerto Rico was devastated by landfalling hurricanes. The 1928 storm, known locally as Hurricane San Felipe II, was the most destructive event to occur in Puerto Rico during the 20th Century, for it crossed Puerto Rico from southeast to northwest and affected all parts of the island. All three hurricanes flattened the sugarcane in the fields and blew the coffee beans and citrus from the trees just at the beginning of the annual harvest.[9] Private capital might have been able to finance the restoration of the fields and plantations after a single natural disaster, but private capital was unable to cope with three natural disasters in a row.

The wind, rain, and floods that accompanied the storms also demolished the housing of thousands of rural agricultural workers, leaving them homeless and destitute; as sharecroppers, they depended on the harvest to pay the annual rent for the houses they occupied and for the food and other goods provided on credit during the year by the farm operators. Thus, in addition to generating an economic disaster, the three hurricanes devastated the social fabric of the island. It was at this time that Puerto Rico was termed "the poorhouse of the Caribbean" by visitors from the mainland.

The Virgin Islands has shared similar experiences, but at different times, for each tropical storm and hurricane has individual characteristics and follows a distinctive track. Many tropical storms move slowly and pour several inches of rain during short periods, creating major floods in the islands. The worst hurricanes move from the southeast toward the northwest, but even if they do not cross the coast of either island, every major storm that passes within 100 miles has an impact, primarily in the form of heavy rains that may cause flooding.

A major hurricane has not affected the islands for many years. However, it is doubtful if the economic effect of a future hurricane would be as devastating as was the case in the 1930's. Federal disaster relief programs are now available in the Territories, and broad scale transfer programs such as Food Stamps (known in Puerto Rico as PAN) would also help farmers to rebuild. The protection against economic devastation from natural disasters is an important positive contribution of Federal policy to Puerto Rico and the Virgin islands which has received little comment from those who have studied these issues.

iii. Shifts in Farm Size, Production and Employment

There has been a major shift away from agriculture during the postwar period, both in Puerto Rico and in the Virgin Islands. Agricultural labor now forms a very small segment of the labor force. Tables 4, 5 and 6, on pages 21, 22 and 23, indicate the nature of the transformation. The availability or non-availability of Federal incentive programs has played a major role in this development.

In Table 4, employment data from the 1980 Census of Population indicate that agricultural employment dropped absolutely in Puerto Rico, from 69 thousand persons in 1970 to 40 thousand in 1980, or from 10.7 per cent of total employment in 1970 to 5.3 per cent in 1980, while total employment increased by 117 thousand, or 16 per cent. In the Virgin Islands, employment in agriculture actually increased slightly in numbers, but retained the same proportional share. Table 5 shows that in Puerto Rico agriculture has been, and continues to be, heavily dominated by part-time workers.

Changes in the agricultural structure in Puerto Rico are shown in Table 6. Both the number of farms and the total amount of land in farms increased between the Census of Agriculture taken in 1978 and that taken in 1982, with the land in farms occupying 44 per cent of the total land area in 1982, versus 43 percent in 1978. But this is about one half of the totals recorded for 1950. Total cultivated cropland increased by 4 per

Table 4

EMPLOYMENT BY SECTOR
Puerto Rico and U.S. Virgin Islands

Sector	Puerto Rico 1970 Number (000)	Per Cent	1980 Number (000)	Per Cent	Virgin Islands 1970 Number (000)	Per Cent	1980 Number (000)	Per Cent
Total Employed	636	100	753	100	24	100	36	100
Agriculture, Fishing, Forestry	69	10.7	40	5.3	.3	1.2	.4	1.2
Constructn/Mining	76	11.9	44	5.8	4	16.3	3.7	10.4
Manufacturing	132	20.8	143	19	2.2	9.1	3.1	8.8
Wholesale Trade	13	2	17	2.3	.4	1.5	.6	1.8
Retail Trade	115	18.1	121	16.1	3.6	14.7	6.1	17
Finance, Insurance Real Estate	13	2	21	2.8	1.2	5	1.9	5.5
Transport, Commun, Public Utilities	45	7.1	47	6.2	2.2	9.2	3.4	9.6
Services	116	18.3	135	17.9	8.3	33.9	12.2	34.2
Public Adminis.	106	6.7	184	24.4	2.2	9.1	4.1	11.5

Source: U.S. Department of Commerce, Bureau of the Census
Census of Population, 1980

Table 5

EMPLOYMENT IN AGRICULTURE
Puerto Rico
(000)

Item	1960	1965	1970	1975	1980
Total Labor Force	625	681	765	872	996
Farm Labor Force	150	126	79	60	57
Total Employed	125	108	68	50	43
Employed Full Time	61	58	40	21	18
Employed Part Time or not working	64	50	28	29	25
Unemployed	24	18	11	10	13

Source: PR Dept of Agriculture:
Annual Statistical Report, 1981

Table 6

TRENDS IN AGRICULTURAL STRUCTURE

Item	1940	1950	1959	1964	1969	1974	1978	1982
NUMBER OF FARMS	55519	53515	45742	44859	32687	29650	18992	21820
LAND IN FARMS								
Cuerdas (000)	1856	1845	1682	1641	1335	1260	980	982
(er Cent of Total	84	82	75	73	59	56	43	44
USE OF FARMLAND (cuerdas -000)								
Cultivated Crops	na	na	na	585	363	353	271	282
Cultivated Pasture	na	na	na	na	na	362	295	270
Natural Pasture	na	na	na	na	na	149	143	156
Woodland	na	na	na	na	na	148	125	165
Other uses	na	na	na	na	na	248	146	109
SIZE OF FARMS - cuerdas								
Less than 10	29370	27985	22967	22664	17238	14318	7031	9837
10 to 19	11288	10538	9654	9578	6579	6083	4788	4554
20 to 49	8575	8687	7788	7570	5045	5293	3910	3937
50 to 99	3200	3166	2621	2428	1683	1785	1409	1549
100 to 174	1504	1440	1212	1040	767	886	773	658
175 to 259	646	627	512	519	426	414	382	372
260 and more	936	1072	1038	1060	949	872	699	712
LAND IN FARMS BY SIZE (cuerdas - 000)								
Less than 10	145	143	115	116	78	65	32	39
10 to 19	151	144	130	131	90	84	66	62
20 to 49	259	264	234	226	150	158	116	118
50 to 99	215	216	177	165	115	122	98	105
100 to 174	192	186	156	134	100	115	100	110
175 to 259	136	133	108	110	90	88	81	79
260 and more	788	758	763	755	712	628	489	468
USE OF IRIGATION SYSTEMS								
Total Farms							685	874
Total Cuerdas							53782	42483
Source of water								
Public system								
Total farms							253	287
Total cuerdas							30745	16011
Private systems								
Total farms							458	545
Total cuerdas							23036	26472

Source: U.S. Department of Commerce, Bureau of the Census
Census of Agriculture (1974, 1978, 1982)

cent from 1978 to 1982. Cultivated pasture declined by 8 percent, while the land in natural pasture increased by 9 percent.

There was an increase of almost 40 per cent in the number of farms with fewer than 10 acres, and an increase of 22 per cent in the land area in such small farms. There was a decline in both the number and area of farms with from 10 to 19 acres, but an increase in the number and area of farms with between 20 and 99 acres. There was a decline in the number of farms with from 100 to 259 acres, but an increase in the land area involved. On the other hand, the increase in the number of farms with over 260 acres was accompanied by a decline in the total land area.

Table 7, on page 26, highlights some of the major changes in basic agricultural activity in Puerto Rico during recent decades. Land in "traditional" crops (sugarcane, coffee, and tobacco) decreased sharply. Land in pineapples declined more slowly, as the Puerto Rican pineapples still appear to have a market.

The number of sugar mills has dropped from 34 in 1950 to 7 in 1980, due to declining production. Although still in private ownership, most of the mills are now operated by the government owned Sugar Corporation, whose primary purpose at present appears to be to sustain a limited amount of agricultural employment in sugar cane cultivation and processing. Under pressure from more stringent health inspections, the number of public abattoirs has declined from 57 in 1970 to 20 in 1980, but those are new, larger establishments with modern equipment and improved sanitation.

Production Incentives

The number of dairy farms rated as first class by the Department of Agriculture was 640 in 1980, a slight increase over 1975, but still 95 fewer than in 1970. However, those 640 dairy farms produced 10.2 per cent more milk in 1980 than the 735 dairy farms of 1970.

A quick analysis of changes in the physical volume of agricultural production over a recent period of 9 years can be made from Table 8, on page 27. Of the traditional crops, coffee production declined and then increased again to higher levels, while sugar and tobacco production declined steadily . Production of plantains, fruits and vegetables has increased, as have poultry, eggs, and ornamental plants. Milk, beef, pork, and fish production appear to have peaked about 1979, and declined by 1981.

Data on gross farm income, shown in Table 9 (page 28), indicate similar changes, but it must be noted that the prices reflect the results of the high levels of inflation that have occurred since 1970.

The characteristics of Puerto Rican farmers have also changed considerably in recent years, as shown in Table 10, page 29. More than 79 per cent of the farm units, 53 per cent of the total farmland, and 55 per cent of the cultivated farmland is operated by persons who own the land. In 1982 the average age of farm operators whose primary activity was agriculture was 56.1 years, while that of farm operators whose farm activity was

Table 7

CHANGES IN AGRICULTURAL INFRASTRUCTURE
Puerto Rico

Activity	1940	1950	1960	1970	1975	1980
Sugar Mills	41	34	29	16	11	7
Acres in Cane(000)		367	328	188	127	85
Yield-Tons/Acre		29	30	31	28	26
Per cent sugar		12.1	10.1	7.7	8.2	7.8
Acres in Coffee(000)		159	160	130	130	99
Yield-QQ/Acre		1.08	2.16	1.54	1.78	2.65
Acres in Pineapple		3960	3360	3651	2672	2574
Yield-Tons/Acre		10.9	13.9	14.8	15.9	14.8
Acres in Tobacco(000)		36	26	5	3	2
Abattoirs			74	57	21	20
First Class Dairy Farms				735	631	640
Milk-Millions of Liters			281	379	389	418

Source: PR Dept of Agriculture:
Annual Statistical Report, 1981
Report on Abattoir Activity, 1984

Table 8

INDEX OF PHYSICAL VOLUME OF AGRICULTURAL PRODUCTION
Puerto Rico (1961-1963=100)

Item	1973	1975	1977	1979	1981
Major Field and Other Crops					
Sugar	24	29	16	19	15
Coffee	80	68	57	62	89
Tobacco	17	13	14	11	6
Starchy Vegetables	98	105	106	114	119
Bananas	93	96	96	96	93
Plantains	117	124	137	153	167
Fruits,Total	88	88	87	90	120
Avocados	125	101	96	77	68
Oranges	103	109	105	103	95
Pineapple	75	76	76	78	76
Citron	59	85	74	70	94
Vegetables, Total	70	71	71	84	91
Animal Products					
Milk	129	128	147	148	140
Eggs	151	169	190	195	209
Beef	157	147	154	206	125
Pork	141	145	185	217	171
Poultry	151	163	191	257	303
Fish	301	326	413	526	418
Ornamental Plants	190	365	446	480	559
Race Horses	145	171	178	189	152
Game Cocks	161	162	169	163	138

Source: Puerto Rico Department of Agriculture:
Agricultural Statistics Annual, 1981

Table 9

GROSS FARM INCOME AT CURRENT PRICES
Fiscal Years
($000,000)

Item	1940	1950	1960	1965	1970	1975	1980	1984
Total Gross Value	84	185	238	273	267	465	580	600
Principal Crops	52	118	110	121	68	104	116	79
Sugarcane*	44	106	90	85	53	87	70	31
Coffee	4	8	20	22	13	15	45	48
Tobacco	4	5	9	14	2	2	1	1
Other Crops								
Starchy Vegetables	1	7	13	18	24	43	60	57
Fruits	5	6	6	8	8	11	15	33
Legumes	1	2	3	3	8	4	6	6
Other Vegetables	1	2	5	7	6	8	12	21
Other Products**	5	4	8	12	23	72	67	73
Livestock Products	19	47	82	105	133	223	303	327
Milk	9	22	43	57	69	117	159	164
Beef	3	7	12	17	21	32	44	56
Poultry	3	8	9	10	12	21	39	39
Pork	3	4	8	9	12	24	31	30
Other Animals			3	4	6	7	13	14
Inventory Change		-1	2	-2	2	3	-8	2

Notes: * Since 1973, includes value of sugar
Notes: ** Since 1973, includes fish and shellfish

Source: Puerto Rico Planning Board: Annual Economic Report to the Governor

Table 10

CHARACTERISTICS OF FARM OPERATORS
Puerto Rico

Item	1940	1950	1959	1964	1969	1974	1978	1982
NUMBER OF FARM OPERATORS, BY TENURE								
Full owners	40522	47821	41226	40323	27757	25489	14617	17294
Part owners	2368	2363	2317	2472	2339	2188	2853	2511
Managers	1303	421	561	507	197	288	417	400
Tenants	11226	2910	1688	1557	2394	1688	1105	1615
LAND IN FARMS, BY TENURE OF OPERATOR (000 Cuerdas)								
Total Land	1856	1845	1682	1641	1335	1260	980	982
Full owners	932	1174	1027	936	715	661	494	537
Part owners	140	204	230	260	359	264	290	249
Managers	574	340	327	350	123	132	76	49
Tenants	240	126	98	95	138	202	120	147
CULTIVATED FARMLAND, BY TENURE OF OPERATOR (000 Cuerdas)								
Total Cultivated	na	na	na	na	363	353	271	282
Full owners	na	na	na	na	195	204	141	156
Part owners	na	na	na	na	89	39	20	62
Managers	na	na	na	na	38	44	25	16
Tenants	na	na	na	na	40	67	35	48
AGE OF FARM OPERATORS								
Agricultural, Total						15738	13568	12604
Under 25 years						137	173	179
25 to 34 years						864	909	972
35 to 44 years						2036	1852	1869
45 to 54 years						3406	2793	2510
55 to 64 years						4652	3746	2958
65 years and older						4643	4093	4116
Average age						56.7	55.2	56.1
Non-agricultural, Total						12322	16881	8777
Under 25 years						97	190	96
25 to 34 years						867	1431	820
35 to 44 years						1953	2784	1724
45 to 54 years						2794	3535	1958
55 to 64 years						3158	3951	1905
65 years and older						3453	4980	2274
Average age						55	55.2	53.7

Table 10 - Characteristics of Farm Operators (continued) page 2

EDUCATIONAL LEVEL OF FARM OPERATORS

Agricultural			
6 years or less		6153	7442
7 to 11 years		1962	2500
Completed High School		890	1317
College 1 to 3 years		363	492
College 4 year degree		245	363
College 5 years or more		149	159
Non-agricultural			
6 years or less		3446	3485
7 to 11 years		1542	1782
Completed High School		1035	1624
College 1 to 3 years		351	600
College 4 year degree		353	566
College 5 years or more		377	512

PLACE OF RESIDENCE OF FARM OPERATORS

Agricultural			
On farm	13227	11152	9349
On another farm	508	491	496
Rural non-farm	975	946	1307
Urban area	854	684	717
Outside Puerto Rico	13	3	6
Non-agricultural			
On farm	9722	13613	5940
On another farm	309	406	208
Rural non-farm	900	1157	1077
Urban area	1242	1270	992
Outside Puerto Rico	31	30	20

MAIN SOURCE OF INCOME OF FARM OPERATORS

Agricultural	9282	6976	6634
Sale of farm products	1455	1304	905
Other farm-related activity	4873	3220	4985
Non-farm activity			
Non-agricultural			
Sale of farm products	310	316	391
Other farm-related activity	365	313	245
Non-farm activity	11478	16140	8095

Table 10 - Characteristics of Farm Operators (continued) page 3

PER CENT OF INCOME OF FARM OPERATORS FROM FARM ACTIVITY			
Agricultural			
Under 25	3646	2547	4235
25 to 49	2201	1770	1948
50 to 74	2997	1926	1604
75 and over	6730	4294	4699
Non-agricultural			
Under 25	9671	6192	7207
25 to 49	1887	1225	1034
50 to 74	292	154	202
75 and over	185	76	227
HIRED FARM WORKERS			
Worked 5 months or more	30611	26391	15621
Worked less than 5 months	50501	36469	34676
SHARECROPPER FAMILIES OR 'AGREGADOS' LIVING ON FARMS			
Number of families	8307	4347	3768
Number of farms	na	1685	1557

Source: U.S. Department of Commerce, Bureau of the Census
Census of Agriculture (1974, 1978, 1982)

secondary was 53.7. In 1982, 18 per cent of the operators whose primary activity was agriculture completed high school or had some education at college level versus 16 per cent in 1978; 38 per cent of those whose farming activity was secondary had attained such higher levels of education in 1982, versus only 29 per cent in 1978.

Puerto Rican agriculture, in sum, is a complex mix that seems to be dominated by small farm units (see Table ~~11~~6) and an aging population. However, the census data also appear to indicate that there is a small, but growing, group of farm operators with higher levels of education who consider farming as a secondary occupation.

iv. Agricultural Planning in Puerto Rico

Several efforts have been made to develop long range plans for Puerto Rico's agriculture, starting with the Report of the Puerto Rico Policy Commission (Chardon Plan)[10] of 1934 and the Koenig Plan of 1952,[11] both of which were prepared for the U.S. Department of Agriculture, but were never implemented. Both were based on Puerto Rico as an agrarian economy. USEDA funded a Technical Assistance Study by Checchi and Company in 1968[12] for the Puerto Rico Cooperative Development Administration to design a program of marketing cooperatives for agricultural products, in an effort to encourage diversification. Due to the change of administration in that year, the program was not followed up.

Production Incentives

In 1977 the 12 year "Program for a Modern Agriculture"[13] was initiated as a major change in agricultural policy by a new governor, and a major effort was made to provide credit and technical assistance to induce farmers to improve their technology and to diversify their production. It was acknowledged that a period of experimentation would be required to identify appropriate varieties of fruits and vegetables and to explore and develop export markets. In 1983, midway through the project period, the Department of Agriculture contracted with Tahal Engineering Company to evaluate the results of that activity and to recommend modifications in the light of the Israeli experience with carefully controlled use of water resources. That report, submitted in March 1984,[14] involved a hard, detailed look at all of Puerto Rico's agricultural sector, with special attention to water use, the need to develop export markets for local products, and the desire to substitute local products for expensive imports. Like others before it, that report has been caught in the aftermath of an election, and it is impossible to predict whether its recommendations will be implemented.

C. Fisheries

There are three major components of fishing activity in the U.S. Caribbean islands: commercial fishing, which involves traditional artesanal fishing for the local market; industrial fishing, which provides the basic materials for the tuna canneries in Mayaguez and Ponce; and recreational fishing, which is oriented toward tourism.

There are 88 recognized groups of fishermen engaged in commercial fishing activity in the coastal waters of Puerto Rico. These are the groups registered with the Corporation for Development of the Marine, Lacustrine, and Fluvial Resources (CODREMAR), an arm of the Puerto Rico Department of Natural Resources. CODREMAR receives annual grants from the National Marine Fisheries Service (NMFS) through the Caribbean Fisheries Management Council (CFMC). NMFS is a part of the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. Federal support for fishermen comes in the form of credit for acquiring boats and equipment, special disaster payments for replacing or repairing of boats and gear destroyed or damaged by storms and other natural events, research activities at the Commercial Fishing Laboratory in Cabo Rojo, and grants from USEDA for the construction of piers, ramps, refrigerated storage facilities, and lockers for various fishing cooperatives.

The artesanal fishermen cling to traditional patterns of activity, such as returning to the home port each night. The fishermen are generally reluctant to undertake new programs or to adopt new technology, having a basic mistrust of government involvement in their activity. At one point, the Community Services Administration bought large new fishing vessels and provided special training in their handling and maintenance, in an effort to induce local fishermen to travel longer distances in search of fishing areas that might produce a larger yield. The effort did not succeed.

Puerto Ricans consume large quantities of fish and seafood,[15] but the local fishermen provide only 10 percent of the demand. Their catch appears to have reached a peak of 6.7 million pounds in 1980, and has declined since that year. Imports of fresh and frozen or processed fish and seafood, from all sources in 1980 totalled 56 million pounds, exclusive of tuna for the canneries, while another 4.5 million pounds were exported, with the major share going to the Virgin Islands.

The tropical waters are relatively shallow, and the insular shelf is narrow; thus, they do not support large fish populations. The expansion of the number of fishermen in recent years may explain in part the reasons for the decline in the total catch. However, Puerto Rico's fishermen have been resisting an effort to create a national marine sanctuary in Puerto Rican coastal waters, having been led to believe that the sanctuary regulations would prohibit their traditional activities. Although the truth is the exact opposite, the fishermen have not reported their catch on a regular basis to CODREMAR's technicians. Thus, a part of the reported decline may be laid to the boycott of government officials, who are seen as proponents of the sanctuary.

Production Incentives

President Reagan's declaration of a 200 mile Exclusive Economic Zone has created some local problems, for the EEZ extends to the easterly shores of the Dominican Republic and into the British Virgin Islands. Negotiations have been under way for some time with the Dominican Republic, which wants reciprocity for its fishermen.

A number of research proposals have been considered to support fishing in the region. One which appeared to have promise was an effort to produce mangrove oysters on a commercial basis so as to generate a sustainable yield, to satisfy year round demand. A small demonstration showed that it is feasible to raise mangrove oysters attached to rafts in quiet waters. A second step demonstrated that it is possible to strip the "spat" and place it under the rafts through special laboratory procedures. A proposed third step would have demonstrated that it is feasible to sustain commercial production on a controlled year round basis. However, it was at that step that the Department of Agriculture decided that it could not afford the $12,000 in-kind matching funds that would have been required to obtain a USEDA technical assistance grant.

The tuna industry is well capitalized. Each 200 foot tuna "clipper" costs upward of $8 million. They have relatively small crews (22 men), and each group of clippers carries a helicopter, with a pilot and mechanic, whose job it is to search out promising fishing areas. The tuna clippers remain at sea for four to five months at a time, searching for fish off the west coast of Africa at certain periods, then moving across to the Pacific Ocean, off the west coast of South America.

The tuna canneries in Mayaguez and Ponce employ upwards of 6,000 persons in cleaning, processing, and packing tuna for export to the United States and other areas. Canned tuna has been exempted from duty-free entry into the U.S. market under the CBI program, to protect that activity against unfair competition from other Caribbean countries. And a special U.S. Treasury ruling made it possible for the tuna fleet to enjoy tax exemption under Section 936. In 1980, the tuna fleet brought almost 360 million pounds of various species of tuna to the canneries. In addition to the familiar canned tuna for human consumption, the plants produce food for pets, marine animal oils, and fish meal, most of which are exported to the United States.[16]

CFMC develops management plans for selected species , and monitors the implementation of the regulations related to rare and endangered species. CFMC also regulates sport fishing that involves rare and endangered species in local waters. The annual billfish tournament of the San Juan Yacht Club attracts recreational anglers from many parts of the world. Fishing charters appear to be much more popular in the Virgin Islands than in Puerto Rico, in part because of the different approach to assessing and taxing the boats.

Of far greater significance for recreational fishing, however, is the fact that there are more than 5,000 sport

Table 12

FISHERIES DATA
Puerto Rico, 1976-1984

Item	1976	1978	1980	1892	1984
Number of Fishermen	na	1402	1447	1872	na
Number of Boats	na	1073	1084	1449	na
Landings (000 lb)					
Total Catch	5868	7046	6669	5775	4648
Fish	na	6056	5610	4620	3713
Shellfish	na	990	1059	1155	935
Avg $/lb	.64	.75	.96	1.16	1.34

NOTE: Data for 1978 and 1982 estimated from incomplete results of annual census of the industry

Source: CODREMAR: Periodic Reports of Fishing Industry Activity

CHAPTER III: INCENTIVE PROGRAMS AFFECTING RESOURCE CONSERVATION

A. Introduction

Water, which is vital for all life, is considered in many areas to be a matter for direct public management. In some situations, water is considered as private property; in others, water is considered to be in the public domain, the common property of all. Land, which is inextricably related to soil resources, also is subject to private ownership, yet becomes a matter of public concern when affected by erosion, or by socioeconomic problems.

In this chapter we will continue our general survey of the current renewable resource situation, with special emphasis on Federal programs affecting these areas. But here, unlike the previous chapter, we will concentrate on resource conservation rather than production. The two principal areas to be surveyed here are soils and water.

B. Soils

The Soil Conservation Service of the U.S. Department of Agriculture (SCS) has made extensive surveys of Puerto Rico and the Virgin Islands, and has produced Soil Surveys which classify all the soils by their productive capacity.[18] SCS has also published a set of maps indicating Prime and Unique Agricultural Lands for the purpose of implementing the relevant Federal legislation.[19] These maps are supposed to guide all Federal agencies, as well as state and local agencies, in the consideration of development proposals. The islands are also subdivided into Soil Conservation Districts. The State Council of Conservation Districts, which in Puerto Rico is chaired by the Secretary of Agriculture, has not provided positive leadership, and the districts are relatively inactive.

The SCS has designed a number of multi-purpose flood control and drainage projects to improve cultivation in some areas of productive soils, and has completed several elements of the programmed activity. However, the rapid urbanization of farmland as the urban centers have been extended has forced SCS to re-evaluate the costs and benefits of some projects to ascertain that major benefits still accrue to agriculture. When the cost-benefit balance changes, the local matching share may become more onerous, and projects may have to be re-designed.

In most instances, the Puerto Rico Aqueduct and Sewer Authority (PRASA) is the agency responsible for sharing the cost, since water supply is one of the basic elements of a multi-purpose flood control project. The Puerto Rico Department of Natural Resources (DNR) is the agency charged with the coordination of all flood control projects on the island, but DNR is unable to make long term commitments for such projects without the active cooperation of the public corporations, such as PRASA, which are responsible for providing the local matching funds.

In the hilly areas, erosion and landslides are still major problems. The Geologic Division of the US Geological Survey has produced a map indicating the susceptibility of various areas of

Puerto Rico to landslide activity.[20] This is only the third map of this nature to have been produced under the Division's national program, because of the severity of the problem in Puerto Rico. However, having been produced at the USGS Menlo Park, California, Center, it is not recorded in the Federal report of expenditures related to Puerto Rico.

The major direct response to landslide and erosion problems is terracing and reforestation. There is no Federal program to address the cost of large scale terracing activity in Puerto Rico or the Virgin Islands at the present time. SCS is oriented toward individual farmers. The State and Private Forestry Program of the U.S. Forest Service (USFS) is being promoted among private land owners by DNR, but the resources available are limited, and the present administration in Washington is seeking to reduce the program still further, if not to eliminate it entirely.

The DNR Forest Service is mounting its own large scale reforestation program, which is oriented in part toward the protection of watersheds. However, most of the land that is critical for this program is owned by individual farmers and landowners. This activity was discussed the previous chapter.

C. Water

i. Availability of Water Resources

Both Puerto Rico and the Virgin Islands experience major problems related to the temporal and spatial distribution of water. In Puerto Rico, the orographic effect of the central mountain range causes most of the rain to fall on the north slopes, creating a severe imbalance. While the average annual rainfall for the entire island is about 75 inches, the precipitation ranges from 200 inches in the Sierra de Luquillo in the northeast to about 35 inches in the southwest corner of the island. A similar, though less extreme, variation is experienced in the Virgin Islands, where each of the islands has slightly different conditions, due to topography and other factors.

Rainfall occurs during most of the year in the form of brief, but very intense showers. Very high intensities have been recorded, as noted in the following data[21]:

Inches	Duration	Place	Event and dates
6.2	2 hours	Pico del Este Sierra de Luquillo	Tropical storm Eloise 16 Sep 1975
18.2	12 hours	Naguabo	Tropical storm San Zacaria 7 Sep 1910
23.0	24 hours	Adjuntas	Hurricane San Ciriaco 8 Aug 1899
19.6	48 hours	Adjuntas	Hurricane San Felipe II 13-14 Sep 1928

The most intense rainfall in short periods appears to be associated with tropical storms or hurricanes, while heavy rains over a longer period appear to be associated with stationary tropical depressions. When combined with the steep terrain and short stream valleys, such rainfall generates flash flooding, with potential loss of life, property damage, erosion, and sedimentation of reservoirs.

Periods of extreme water scarcity have also been experienced in the islands. Because of the distribution patterns indicated above, one area may be suffering the consequences of drought while others remain unaffected. St. Thomas in the Virgin Islands is the area most seriously affected by this phenomenon, at times in the past having had to import water by barge from Puerto Rico. The U.S. Army Corps of Engineers is presently investigating the feasibility of constructing an underwater pipeline from Puerto Rico to St. Thomas to alleviate that situation. In Puerto Rico, PRASA is progressing slowly with a long range program to interconnect the several public water supply systems, so as to be able to alleviate local drought conditions.

In Puerto Rico, water is an element in the public domain, although riparian rights for surface waters may accrue to private landowners. In the Virgin Islands, the scarcity of water led to a long-standing local requirement that every structure must have its own rooftop rain water collection system feeding into a cistern. At the same time, there were extensive paved catchment areas on the hillsides, with large cisterns that fed public water mains. Rapid population growth has outpaced the capacity of the public catchment areas and cisterns, however, and desalination plants have had to be installed in St. Thomas. Some residences in Charlotte Amalie are still served by three water supply sources: the public cistern system, supplemented by the private cisterns for potable water, and a separate salt water system for sanitary wastes.

There is only one natural fresh water lake in Puerto Rico, the Tortuguero Lagoon on the north coast. There are no natural lakes in the Virgin Islands. PRASA has built a number of single-purpose reservoirs for domestic and industrial water supply. During the first part of the century a number of multi-purpose reservoirs were constructed by predecessors of what is now the Puerto Rico Electric Power Authority (PREPA) to generate hydroelectric power and to provide water for irrigation on the south coast. The Bureau of Reclamation of the U.S. Department of the Interior provided consulting services for these projects. Some of these systems involve the transfer of water from the north slope of the mountains, where it is relatively plentiful, to the south. Due to an apparent desire to minimize land acquisition costs and a lack of effective knowledge or concern about sedimentation at the time the systems were designed and constructed, no provision was made to control erosion in the drainage basins that fed the reservoirs, and most of them now have lost considerable capacity.

For use in the Federal Study of Puerto Rico, the USGS prepared a summary of the current state of knowledge about Puerto Rico's water resources.[22] This short publication provides a good introduction for anyone looking into the field for the first time. In addition, the Corps of Engineers in 1977 published an independent analysis of the water resources of Puerto Rico as a basis for its study of the Ponce Region, and identified a number of potential reservoir sites. It also published a through survey of the water supply situation for the entire island in 1980.[23] The SCS has conducted a similar independent survey on an island-wide basis, but its effort was limited to smaller scale projects.

Responsibility for the planning and management of all water resources was assigned to DNR (the Puerto Rico Department of Natural Resources) when that agency was established in January 1973. A new water law was enacted in 1976, providing for the preparation of a water plan as well as for a new water regulation. Despite the clear mandate for DNR, some overlap and duplication has existed in island water supply planning. For example, PRASA produced a preliminary water plan, which was completed in 1983 but never officially accepted.[24]

The Water Planning Division of DNR has also continued the study effort; several preliminary drafts have been prepared for a comprehensive water plan based upon available knowledge. Elimination of the WRC and the consequent loss of water planning funds delayed the completion of that activity. A revised plan was completed and circulated for review in 1985.[25]

As an element of its planning effort, DNR has had to identify the existing franchises for taking surface water, some dating back to the Spanish colonial administration, and to plot the location of all wells. A new water regulation on the taking of water was promulgated by DNR in 1984, and went into effect early in 1985. Eventually, it is anticipated that all wells will be metered, and that DNR will collect appropriate fees related to the use made of the water. The income from the fees will enable DNR to enforce its water regulation effectively through increased monitoring of wells and franchises.

A detailed multi-year study of Puerto Rico's North Coast Aquifer is now under way by the Caribbean Area Office of the Hydrology Division of USGS, with financial support from DNR, the Puerto Rico Environmental Quality Board (EQB) and the Puerto Rico Manufacturers Association (PRMA). That activity is an element of the regular work program of the Area Office of USGS and is not separately identified in the Federal expenditures reporting system. Need for that study was accentuated by several incidents of contamination of local water systems supplied by wells, as well as by spills of toxic industrial materials.[26] The U.S. Environmental Quality Board (EPA) is coordinating the efforts to trace and eliminate the sources of contamination within its regular work program. That activity also cannot be separately identified in the Federal expenditure reports.

ii. Water Supply Systems

In Puerto Rico, PRASA is responsible for water supply in all areas of the Commonwealth. In the Virgin Islands, the Water and Power Authority (WAPA) has a similar responsibility. Each is a public corporation having the ability to raise capital through the sale of revenue bonds.

PRASA uses its revenue bonds only to finance expansions to the urban water supply systems. The Legislative Assembly of Puerto Rico funds PRASA's capital investment requirements for rural water systems, and makes up the operating deficits for those systems, which are generally isolated and serve a small number of families. In both Puerto Rico and the Virgin Islands, developers are required to install the water mains in new subdivisions, meeting standards prescribed by the public authorities. In conducting its survey of wells, DNR's Water Planning Division discovered that the Rural Housing Administration, an arm of the Department of Housing, was drilling wells and building its own small rural water supply systems, bypassing both DNR and PRASA. That practice has now been stopped. PRASA also has some wells that are operating without DNR permits.

Water losses in the delivery system are a major problem for PRASA. Losses from the water mains, between the filter plants and the house meters, amounted to 40 per cent of the total water processed in the plants in 1984. In 1973, the figure for such water loss was 30 per cent. On the basis of such losses, water conservation must become an important element of any plan.[27]

iii. Water Quality

Until relatively recent times, the quality of surface and ground water in both jurisdictions was excellent. However, unregulated draw-down of water in the aquifers underlying the coastal lowlands has permitted the intrusion of salt water in a number of areas, making parts of the aquifer unfit for human consumption, for agriculture, and for many industrial uses. Similarly, aquifers have been found to be contaminated by toxic materials, some of which were released into the ground by accident. If the origin of such materials can be traced, attempts are made to recapture the materials, where feasible, and to close off the source.

Contamination of water by sanitary wastes has been a perennial problem in the islands. Some health problems have been associated with impure water. Some public investments were made in municipal sewage treatment plants, but for many houses, septic tanks were the primary method of handling such wastes. Since 1970, however, Puerto Rico and the Virgin Islands have participated in the national water pollution control program, and have been designing and building large regional collection and treatment systems in accordance with island-wide plans accepted by the Environmental Protection Agency (EPA).

A major problem in the tropical islands stems from the statutory requirements of the Water Pollution Control Act (PL 92-500) which requires all publicly-owned and operated sewage treatment plants to provide secondary treatment. In view of the very real potential for power failures and other malfunctions to occur in the island situations, EPA has made it a general rule that the regional treatment plants along the coast must be designed with both secondary treatment and deepwater ocean outfalls. This requirement, which is indicative of a lack of technical knowledge about the tropical island situation among the drafters of legislation in Washington, was strongly protested, but to no avail. Large sums have been invested unnecessarily in secondary treatment systems where simple primary treatment and an ocean outfall would have sufficed.

Although EPA has relaxed the requirement for secondary treatment recently, many of the large regional treatment plants have already been designed and completed or are nearing completion. By arrangement with the Farmers Home Administration (FmHA), PRASA has obtained grants under FmHA's Rural Water and Sewer Facilities Program with which to construct small secondary treatment plants in small rural municipalities (under 20,000 urban population) that require new new treatment plants or the upgrading of existing treatment plants to meet current EPA standards.

Although PRASA has been able to make its own investment in urban water supply expansion through revenue bonds, and has made an adjustment to its water rates to accommodate the increased cost of operating the new sewage treatment plants, it must depend upon legislative appropriations and on contributions from developers to raise the local funds required to match the available EPA construction grants. When the sewage system construction program was first announced, it was estimated that the cost of the system in Puerto Rico would be about $400 million.[28] Since then, the estimated cost has risen so much that there is no assurance that either local or Federal funds will be available to complete the effort.

To further complicate an already difficult situation, the local water treatment agency (PRASA) is under court order to imporve local treatment facilities. Until this is done, EPA has barred new connections to sewers served by 47 treatement plants on the island. This action has virtually paralyzed new construction in many parts of the island. PRASA has proposed a plan to resolve the problems, but it will take until 1986 to complete, even under the most optomistic estimates.[29] The local government, meanwhile, proposes to push ahead on several public housing projects using septic tanks as a temporary stopgap measure.

Oil spills in offshore waters pose a continuing threat to the coastal resources of both Puerto Rico and the Virgin Islands. Tankers bound for the refineries on St. Croix and at various sites in Puerto Rico, or traversing the sheltered shipping lanes of the Caribbean Sea and the Mona Passage en route to other destinations, have run aground or broken up, releasing large quantities of crude oil or petroleum products. Although the U.S. Coast Guard has the primary statutory responsibility for cleaning up such spills, DNR, EQB, and many other local and federal agencies become involved in related activities, such as rescuing aquatic birds and marine species that may be affected by the materials. With a grant from the Coastal Energy Impact Program (CEIP) of the National Oceanic and Atmospheric Administration (NOAA), DNR recently designed and published an atlas of the coast of Puerto Rico which indicates priorities for attention in the event of future oil spills, as related to the presence of coastal mangroves, rare and endangered species, and other criteria.[30]

iv. Water Demand

The four major users of water in the islands are agriculture, thermo-electric generating stations, industry, and domestic use. An evaluation of the water resources in the area (Caribbean Region Report of the National Water Resources Study, 1975(?)) indicates recent knowledge of the availability and demand for water by general sector.

All four types of use require good quality water: domestic use for health, taste, and esthetic reasons; agriculture because inappropriate chemical content will leave saline deposits in the soil which may make it unfit for continued cultivation; thermo-electric generating stations because inappropriate chemical content will cause a buildup of scale in the boiler tubing, which increases the time required for servicing and reduces operating efficiency; and industry because in many instances, particularly in food processing and pharmaceuticals, high levels of water quality are essential to maintain acceptable product standards. Within certain environmental constraints, generating stations and other water-related industries may use sea water for cooling.

At one time, both Puerto Rico and the Virgin Islands anticipated high levels of investment in petroleum refining and downstream petrochemical satellite activities. Puerto Rico considered a nuclear powered generating station on the south coast that would produce water as a byproduct, to permit industrial and other development in an area that could not be developed because it was perennially short of water.[31] The nuclear plant, originally conceived prior to the passage of the National Environmental Policy Act (NEPA), was effectively halted when the .pa Corps of Engineers denied a crucial permit on the grounds that the site was affected by a geologic fault.

As an outgrowth of a proposal to restore the capacity of the Guayabal Reservoir for irrigation, Puerto Rico developed preliminary plans for a five-stage, $225 million Toa Vaca Transmountain Water Diversion Project, which was expected to provide water for continued economic development of the water-short south coast. The first stage of the project was built in 1967-68 with $7.2 million in grants from the Economic Development Administration of the U.S. Department of Commerce (USEDA).[32] Subsequent actions by the (OPEC), virtually erased Puerto Rico's hopes for the petrochemical complex and eliminated the urgent need to provide additional water for industry on the south coast for some time. The energy inflation that accompanied the OPEC actions has doomed the Toa Vaca project

In the area of agricultural water demand, a number of problems exist. One is the economic viability of operating

Conservation Incentives

Puerto Rico's four irrigation districts, which were originally based upon the cultivation of sugar cane, but which are now being used for other purposes. The irrigation practices still in use on a majority of the farms are wasteful, inefficient, and costly. The 1982 Census of Agriculture indicates that proportionally fewer farmers are using the public water sources. New, more efficient irrigation technology is available, but it is costly, and the level of agricultural credit is insufficient to help farmers who wish to acquire the appropriate equipment. Another problem appears to be a propensity for planners in various public agencies to assume that water is not a problem, and to prepare or to undertake major long range development proposals without assuring that the water will actually be available in the quantities required. This has been brought to the fore recently when DNR received two requests for water from the same major river basin, one from PRASA for long range expansion of the domestic water supply for the San Juan Metropolitan Area, and the other from the Department of Agriculture for large amounts of water to permit the expansion of rice cultivation.

Obviously, it is essential to have a central water planning and management agency to develop a comprehensive approach to the availability, actual and potential demand, and most appropriate and efficient uses for water, based on a consideration of alternatives. The DNR staff has attempted to meet that need, but stronger support is required to establish a firm public policy.

SECTION 2: SPECIAL FEDERAL PROGRAMS

CHAPTER IV: U.S. SOCIAL SUPPORT PROGRAMS AND RENEWABLE RESOURCES

A. The Growth of Social Support Programs

One of the most pervasive features of U.S. policy toward the Territories has been to emphasize those solutions to social problems which are currently in vogue in Washington. Typical of this tendency is the rapid growth of social support programs in Puerto Rico and the Virgin Islands during the same period when the "Great Society" programs were being expanded on the U.S. mainland.

This growth was very rapid. The Kreps Report on Puerto Rico, completed in 1979, describes these developments as follows:

> ". . . there has been a sixfold increase in gross Federal transfer payments to Puerto Rico during the 1970-77 period, with the greatest increase occurring in 1975 with the introduction of the Food Stamps program. More importantly, there has been a fifteenfold increase in the net inflow of transfer payments over these years."[33]

Nevertheless, although much discussion has been devoted to Food Stamps, which were very large for the size of the economy and which clearly did grow very rapidly, rapid growth occurred in a wide variety of other programs as well. Table 13 on the following two pages shows these trends clearly. Table 14 shows the same panorama in a somewhat different way, and includes a breakdown of some of the Federal support programs directly affecting agriculture.

Table 13

FEDERAL SOCIAL SUPPORT PROGRAMS IN PUERTO RICO
Fiscal Years, 1973-1982
Millions of Current Dollars

Item	1973	1974	1975	1976	1977	1978	1979
Total Transfers to Individuals	747.6	670.1	1131.5	1640.4	1822.9	2015.8	2207.6
Food Stamps			280.5	593.1	616.5	670	733.1
WIC	.2	.2	2.2	6	9.7	11.1	9.1
PellGrants (BEOG)	2.4	2.9	12.8	55.5	98.3	111.8	120.1
Veteran Benefits	109.3	119.2	148.4	176.6	165.4	175	187.5
Medicare	208	39.5	50.5	56.8	71.6	80.8	71
Social Security	333.2	397.7	486.4	574	680.6	742.6	905.2
Unemployment	60.3	74.4	109.3	123	118.3	109.6	110.8
Retired Military	17.7	19.6	22.5	24.5	28.4	30.5	32.3
Ret.Civil Svc	16.5	20.8	24.4	30.9	33.8	34.4	38.5
Total to State & Local Govts	230	248.2	328	391.3	476.8	565	767.4
School Nutrition	21.7	30.4	37.3	42.2	61.4	66.7	72
Education, Gen	44.4	47.9	63.6	83.1	109.1	153.8	172
Health/Welfare	119.4	117.7	115.1	137.2	136.6	136.3	199.4
Emplmt & Trng	44.5	52.2	112	128.8	169.7	208.2	324
Less Payments to U.S.	356.3	427.4	592.3	700.5	739.5	770.1	799.1
Net Federal Benefi	621.3	490.9	867.2	1331.2	1560.2	1810.7	2175.9

Source: Puerto Rico Planning Board:
Economic Report to the Governor

1980	1981	1982
2617.2	2826.5	3084.8
827.1	879.1	876.8
16.2	20.5	24.1
115.3	118.8	135.9
209.2	220.7	237.6
118	143.2	171.6
1126.1	1251	1356.2
126.1	107.5	176.7
37.4	40.6	43.4
41.8	45.1	62.5
734.4	720	720
56.1	85.1	93.5
178.1	177.8	169.9
203.2	220.5	227.2
297	236.6	105.6
869.1	923.4	968.4
2482.5	2623.1	2836.4

Table 14

TRANSFERS BETWEEN PUERTO RICO, FEDERAL GOVERNMENT, STATE GOVERNMENTS, AND OTHER NON-RESIDENTS

Millions of current dollars

	1940	1950	1960	1965	1970	1975	1980	1984
Total U.S.	12.2	69.1	95.6	136.7	306.8	1184.3	2445.7	3173
To Individuals	1.4	50.4	79.6	122.7	284.4	1141.3	2368.9	3090.3
Veterans, Total	1.3	49.7	40.8	37.4	76.9	178.4	223.3	303
Pensions	1.3	38.5	38.8	32.7	66.4	158.2	194.9	254.6
Retired Military		1.3	1.9	4.6	8.6	18.7	26.4	46.2
Vet Life Insurance		9.2	.1	.1	2	1.5	1.8	2.2
EmployeCompensation	.1	.1	.4	.2	.3	1.4	1.6	2
Medicare					24.1	41.3	117.9	185.8
SocialSecurity			36.9	82.4	174	467.9	1041.3	1527.6
Scholarship Aid						23.3	116	128.4
CivSvcPensions		.6	1.5	2.8	7	22	29.8	76.9
Rent Subsidies					2.1	9.6	26.5	48.2
Nutrition Assist						388.4	812.1	765.1
Other						8.9	.4	3.3
Subsidy to Industry	10.8	18.7	15.1	14	17.8	30.8	48.2	54.7
Agriculture,Total	10.8	18.7				4.8	1	2.4
Sugar Act	9.5	17.7	14.2	13.1	6.8	3.3		
Conservation	1.3	1	.9	.9	.8	1.6	.8	2.1
CODREMAR								.3
Public Enterprises						25.9	55.6	52.3
Private Institutions			.9		4.6	12.2	21.4	28
State Governments			1.6	6.1	5.9	19.1	13.4	16.2
Other						25.4	113.7	212.9
Total Received	12.2	69.1	97.2	142.7	312.7	1228.8	2573.7	3402.1
Less Total Disbursed	2.2	5.7	43.8	109.5	248.9	597.4	847.5	1113.3
Net Transfer Income	10	63.4	53.4	33.2	63.8	631.3	1726.1	2280.8

Source: Puerto Rico Planning Board:
Economic Report to the Governor

Social Support

Among the income transfer programs, the largest have been Social Security, unemployment compensation, and Veterans Benefits. Of course, Puerto Ricans pay taxes to support the first two programs, although the table does not reflect these payments. The benefits paid to island residents have generally been substantially higher than their tax payments.

These programs have had considerable influence on the local economy. In recent years the proportion of disposable income coming from Federal transfer payments has been close to thirty percent, and roughly half the households on the island have been receiving food stamp payments.[34]

In addition to the transfer payments the Federal government has also increased other types of programs related to economic and social development in general. When considered in this larger sense, the range of social support programs related to renewable resources becomes very broad indeed, ranging from family planning and health, through those that provide education, housing, and special services in rural areas. Some Federal programs and activities related to social support affect renewable resource development directly, while others have less immediate effects. As one example, family planning and health programs affect birth and death rates, increasing the numbers of people who must be fed, clothed, educated, housed, and otherwise provided for.

Table 13 shows the recent growth of Federal programs in these other areas. In contrast to the 1970's, the growth of these programs has moderated since 1981 as the Reagan Administration has put the brakes on Federal funding generally. And despite the rapid growth of funding shown in Table 13, Congress never did give Puerto Rico full participation in several important programs. Puerto Ricans are not eligible for SSI, and caps have been placed on Medicare and AFDC funding.[35] Also, Puerto Rican agricultural labor was excluded from Social Security coverage when that system was first extended to the island. Significantly, Congress in 1983 also removed Puerto Rico from full coverage in the Federal Food Stamp program and placed the island under a special block grant of $825 million. Puerto Rico administers its own nutrition assistance program (NAP) with these funds, paying beneficiaries with checks instead of food coupons.[36]

The Federal Minimum Wage should also be mentioned here. This legislation is not usually included in discussions of Federal Funding, but it has had a major effect on renewable resource activities in Puerto Rico. Beginning in the late 1930's the Federal Government began to phase in the Federal minimum on the island. At first, different wage levels were set for different industries according to their ability to pay. Coverage was gradually extended and the level of the salary minimum raised.[37]

In 1977, after a Statehood-oriented administration took power, these trends were accelerated with the encouragement of the Puerto Rican government. Full coverage of the Federal minimum wage laws in Puerto Rico occurred in approximately 1981, and unlike other Latin American countries the enforcement of this legislation has been reasonably good. This change, plus local legislation which increased fringe benefits substantially, has raised Puerto Rican labor costs substantially in recent years.

B. Special Needs for Social Support Programs

Major structural changes had occurred in the economies of Puerto Rico and the Virgin Islands prior to the expansion of the Federal social suppport programs of the past fifteen years, and these changes greatly increased the need for them. Up to the early postwar period Puerto Rico and the Virgin Islands were heavily dependent on subsistence agriculture and sugar production. They had very low living standards, with most of the social problems which currently affect the third world countries of Latin America: disease, ignorance, primitive technologies, and lack of capital.

With "Operation Bootstrap" in Puerto Rico and generally closer economic relations with the mainland in both jurisdictions, this situation changed extremely rapidly in the first two decades of the postwar period. Table 15 shows the rural - urban shift in Puerto Rico and the Virgin Islands over the last fifty years. Agriculture virtually ceased to exist as a major economic activity in the Virgin Islands by 1965. And although Puerto Rico has not experienced such an extreme change, it has undergone a dramatic contraction of its agricultural sector, particularly sugar, which was intensive in the use of unskilled labor. Later

Table 15

URBAN/RURAL POPULATION
(000)

	Puerto Rico			Virgin Islands		
Year	Urban	Rural	Per cent Rural	Urban	Rural	Per cent Rural
1930	427	1117	72	13.5	8.5	39
1940	566	1303	70	14.3	10.6	43
1950	895	1316	60	15.6	11.1	42
1960	1039	1310	56	18	143.1	44
1970	1575	1137	42	15.2	47.2	75
1980	2134	1062	33	37.7	58.8	61

Source: U.S. Department of Commerce, Bureau of the Census: Census of Population the island lost large amounts of employment in labor intensive industry as international economic conditions changed and island wage rates increased. Puerto Rico has not been able to develop substitute sources of employment for the displaced workers on a sufficiently large scale, nor has outmigration to the mainland completely taken up the slack.

This massive change has in turn generated large social problems, creating a special need for massive social support, especially in Puerto Rico. The rapid shift from the rural to urban environment has uprooted old customs and traditions and put a major strain on people's adaptive capacities. It has not always been easy for unskilled workers displaced from the shrinking agricultural sector to find other types of employment which fit their skills and experience. Also, the local educational system has many flaws, and is not preparing younger people for useful work either on the islands nor on the U.S. mainland. At the same time, the islands, particularly Puerto Rico, have experienced high rates of alcoholism and drug abuse in recent years. In part, these are symptoms of the problems brought on by these rapid economic and social changes. And the local government still does not have the fiscal resources to provide the needed increase in social services to deal with these problems. In this type of environment, brought on in part by U.S. policies, there is a particular need for social support programs, particularly those which provide incentives for additional training (on the side of the worker) or employment (on the side of the businessman).

C. Population - Resource Balance

Another aspect of this whole issue is the balance between population and resources. Since World War II the birth rates in both Puerto Rico and the Virgin Islands have declined, sharply in the case of Puerto Rico and less rapidly in the case of the Virgin Islands, for various reasons. Tables 16 through 18 on pages 68 through 70 show these changes in various ways. Besides the declining birth and death rates it is important to note the rapid increase in inmigration to the Virgin Islands since 1970 (Table 17) in response to economic opportunities created by the growth of tourism. Many of these people have come from other Caribbean islands. Industrial growth in Puerto Rico has not created a similar situation there; on the contrary, outmigration from that island continues at a fairly rapid pace, as Table 18 on page 70 shows.

First of all, it is clear that Federal programs have affected population growth in various was. Federal and state programs of birth control education have played some role, as has the improved economic situation in many families, brought about in part by economic growth and part by Federal programs. Improved health care has reduced the rate of infant mortality, on the one hand, and of the mortality rate in general, on the other. Thus, the chances are better that a new-born infant will survive to maturity, and that adults will live longer. On the other side of the coin, it is certainly possible that the inequality of

Table 16

BIRTH AND DEATH RATES
Puerto Rico and the Birgin Islands

Year	Puerto Rico Birth Rate	Puerto Rico Death Rate	Puerto Rico Infant Mortality	Virgin Islands Birth Rate	Virgin Islands Death Rate	Virgin Islands Infant Mortality
1940						
1950						
1960						
1970	26	7	29	39	6	
1971	27	6	27	36	7	
1972	25	7	27	34	6	
1973	24	6	24	31	6	
1974	25	6	23	30	6	
1975	24	6	21	28	5	
1976	25	6	20	27	5	
1977	25	6	20	25	4	
1978	25	6	18	24	5	22
1979	24	6	20			
1980	23	6	18	21	4	24
1981	22	6	19			
1982	21	6	17			
1983	21	7	17			
1984						

Source: Health Department Vital Statistics

NOTE: INCOMPLETE DATA

Table 17

POPULATION CHANGE
Puerto Rico and U.S. Virgin Islands
Census Data, 1940 to 1980, (000)

	Puerto Rico			U. S. V. I.		
Census Year	Total	Change	Per Cent	Total	Change	Per Cent
1930	1544	nc	nc	22	nc	nc
1940	1869	325	21.1	25	3	13.2
1950	2211	341	18.3	27	2	7.2
1960	2350	139	6.3	32	5	20.2
1970	2712	363	15.4	75	43	133.7
1980	3197	485	17.9	97	22	28.6

nc = not calculated

Source: U.S. Dept of Commerce, Census Bureau, Decennial Census Reports

Table 18

BASIC ELEMENTS OF POPULATION CHANGE
Puerto Rico, 1970-1984
(000)

Year	Births*	Deaths	Natural Increase	Net Migration	Net Change	Estimated Total
1970	70	18	52	-44	8	2716
1971	74	18	56	-3	53	2769
1972	72	19	53	24	77	2846
1973	71	19	52	-37	15	2861
1974	73	19	54	-25	29	2890
1975	72	19	53	-5	48	2938
1976	76	20	56	36	92	3030
1977	78	19	57	-5	52	3082
1978	78	20	58	-20	38	3120
1979	77	20	57	-6	51	3171
1980	76	20	56	-16	40	3211
1981	74	21	53	-10	43	3254
1982	72	21	51	-33	18	3272
1983	68	22	46	-44	2	3274
1984	65	22	43	-38	5	3279

Note* Adjusted for 4 per cent estimated under-reporting of births in accordance with Planning Board practice.

Sources: Puerto Rico Department of Health: Annual report of Vital Statistics welfare benefits between the islands and the mainland could have artificially stimulated outmigration during the postwar period.

Other things being equal, improved diet, health and education from social support programs increase the number of persons who must be fed, clothed, and housed, almost all of which require renewable resources of various kinds. And there is no doubt that Federal food and nutrition programs have exerted a constant and growing demand for locally produced foods. Puerto Rican dairy farms are now able to satisfy the local demand for pasteurized fresh milk, but the demand for other dairy products, such as butter, cheese, and ice cream, must be satisfied by imports.

On the other hand, social support programs have probably reduced the strain which a large population places on the natural resources of the islands. First, they reduce the dependence on wood for fuel, avoiding the large - scale deforestation which has occurred in many other parts of the world. Beyond this, social support programs reduce the dependence of very poor families on subsistence agriculture and permit them to consume substantial amounts of imported products. Of course, the growth of transfer payments did not really cause a change in dietary preferences, but merely facilitated it. Although the vast majority of the population holds to the tradition of rice and beans, there have been many changes, induced by several factors that relate to other Federal policies and programs.

Social Support

For instance, Puerto Rican youths in large numbers served in the armed forces, travelling to all parts of the world. Many remained in military service and are now beginning to return to the Islands as retirees, with relatively high incomes and different consumption patterns. Their return to the Islands is not always accompanied by a return to the traditional diet, for they have developed new and different habits and tastes that affect renewable resources, and not only in terms of agricultural products.

Likewise, many Island residents have continued their education at institutions on the mainland, supported by the various educational programs. They have also been exposed to vastly different life styles, and return to their home islands with new dietary habits, not to mention heightened concerns about nature and environmental issues, which carry over into their work and family living patterns.

With the end of the war and the beginning of Operation Bootstrap, the migration between Puerto Rico and New York increased drastically, with much the same effect. And the introduction of mass media, including television, to Puerto Rico also tended to break down old dietary habits. In the Virgin Islands, on the other hand, exposure to exotic creature comforts is more direct, because so many people come into contact with the world of tourism, and particularly with the materialism generated by the emphasis on the free port to take advantage of the special customs regulations pertaining to the Virgin Islands.

Social Support

Though the specific causes affecting dietary habits in the two jurisdictions may have been different, the results were much the same. In the postwar period both began to import foodstuffs that were not or could not be produced locally. For example, ordinary white potatoes, in many different forms, now play a major role in the insular diet, although none are produced on the islands, while breadfruit, which at one time was a staple starchy vegetable that grew practically wild, no longer has economic importance, although it is available in small quantities in the local produce markets.

As we pointed out earlier, these changes of taste in favor of imported products, combined with economic growth and transfer programs which allowed people to satisfy these tastes, may have helped to reduce the load on cultivated land in the islands. And even if tastes had not changed, the slow pace of agricultural transformation, pointed out above, would have made it a practical impossibility for the islands to come anywhere close to self sufficiency in food production.

Due to the many influences toward the changing of traditional attitudes which we mentioned above, camping, hiking, swimming, and recreational boating are becoming "growth" activities, and many of the people who are actively involved are also concerned with the condition and status of the beaches, coastal waters, and forests in which they are active.

Social Support

It is the younger people who are becoming involved in the reforestation program. The majority of the farmers are now over 55 years of age, and are not likely to live to reap the benefits of long term reforestation projects. Long term forestry programs require the preparation of technicians who will be providing assistance and advice to the farmers who desire to participate in the program.

On the other hand, many other changes such as urbanization and industrial pollution were working to degrade the environment, and social support programs probably played some role in accelerating these changes as well, not to mention other Federal programs. On balance, then, we can say little about how Federal programs in general, and social support programs in particular, have affected the population - resource balance in the islands. However, it seems clear that many of these complex effects have been favorable, at least in this particular area.

D. Incentives for Work and Production

There exists a widespread view in Puerto Rico and the Virgin Islands that the advent of large - scale social support programs has sharply reduced the motivation of local residents to work. This is particularly true in connection with the Food Stamp program, which brought large, sudden increases in income to a large number of families on the island. The Federal minimum wage was also quite important, as it was most likely an important factor in the rapid rise of local wage rates in the postwar period.

From an economic point of view, it is difficult to imagine that changes of such a magnitude could occur without having some effect on incentives. Yet there is a distinct scarcity of empirical studies which have examined in detail the size and nature of these effects. Here we will review briefly some of the more important studies which have been made in each of the areas related to this whole issue, and try to draw some general conclusions from them.

i. Social Support and Work Incentives

There has been a sharp drop in the proportion of the Puerto Rican population which is economically active in recent years. This trend shows up clearly in Table 19, page 76, for Puerto Rico, though evidence is lacking for the Virgin Islands. In addition, there is much anecdotal evidence concerning shortages of available labor, especially in the rural areas. Many people attribute these changes to the introduction of social support payments. Yet there are many possible causes of these trends, and hard evidence concerning the contribution of social support payments to this situation is difficult to find.

For example, if social support programs had reduced the motivation to work, one would expect to see a decline in the proportion of locally produced food in total food consumption. Yet one sees no such trend in Table 20, on page 77. If anything, this evidence seems to suggest the opposite trend.

Table 19

LABOR FORCE AND EMPLOYMENT
(000)

PUERTO RICO

Year	Personsof Workg Age	Labor Force	Partici-pation Rate (%)	Total Employed	Total Unempl.	Unemploy-ment Rate (%)
1940	1154	602	52	512	90	15
1960	1383	625	45	543	82	13.2
1965	1518	680	46	634	76	11.2
1970	1718	765	44	686	79	10.3
1975	1952	825	42	699	125	15.3
1980	2093	907	43	753	154	17
1984	2261	952	42	742	209	22

J*
BJ2B'**BB
rJjR~

VIRGIN ISLANDS

Year	Personsof Workg Age	Labor Force	Partici-pation Rate (%)	Total Employed	Total Unempl.	Unemploy-ment Rate (%)
1970		25.7		24.5	1.2	5
1980	59.3	38.1	64	35.6	2.3	6

Note: Population of working age included 14 and 15 year olds until 1976, then started with 16 year olds.

Source: Annual economic reports

Table 20

PRIMARY SOURCES OF FOODSTUFF CONSUMED IN PUERTO RICO TO RICO
($000,000)

Year	Total Personal Consumption of Food *	Value of Imported Food (Net)**	(Adjusted) ***	Net Local Value	Products Per Cent of Total
1947	233.5	83.8	167.6	65.9	28
1950	239	89.3	178.6	60.4	25
1955	321.4	127.1	254.2	67.2	21
1960	423.3	156.8	313.6	109.7	26
1965	568.6	200	400	168.6	30
1968	711.1	248.3	496.6	214.5	30
1970	852.9	306.8	613.6	239.3	28
1973	1200	621.6	1243.2	-43.2	****
1975	1669.2	786.9	1573.8	95.4	6
1976	2106	900.8	1801.6	304.4	14
1977	2252.4	983.5	1967	285.4	13
1978	2324.9	1042.6	2085.2	239.7	10
1979	2420.2	1144.1	2288.2	132	5
1980	2779.5	1041.4	2082.8	696.7	25
1981	2980.7	1139.2	2278.4	702.3	24
1982	2936	1137.1	2274.2	661.8	22
1983	3026.4	1146.8	2293.6	732.8	24
1984	3130.1	1137.2	2274.4	855.7	27

Notes: * Total expenditures for food
** Net of returns, re-shipment, etc.
*** Based on an estimated 100% markup to retail cost
**** Extraordinary adjustment of inventories related to long shipping strike

Source: Puerto Rico Planning Board,
1984 Report on Income and Product

Likewise, a survey by Marianne Hill of wage and employment trends shows little or no evidence of any sharp decrease in the supply of labor in Puerto Rico around the time when food stamps were introduced. The conclusion of this study is as follows:

> "In brief, there is little evidence that food stamps have raised wage levels. The value of food stamps is low in comparison to wage levels provided by the minimum wage and any impact of the Food Stamp Program on wages is obscured by the rapid increase in the minimum wage since 1974. On the other hand, it may be the case that employment has fallen among food stamp participants. However, increasing incomes among those who are employed and rising education levels indicate that the added income from food stamps enabled at least some recipients to invest in their families and to seek more stable and higher income employment opportunities."[36]

iii. Social Support and Unemployment

In contrast to the effect on work incentives, which does not appear to be large enough to measure with available data and statistical techniques, the effect on unemployment rates may have been substantial. Table 18 bears out this hypothesis, showing a substantial increase in measured unemployment after 1975 in Puerto Rico, when the increase in social support programs had gotten under way in earnest. The usual explanation for this effect is that people who have some alternative source of income to fall back on can afford to spend more time searching for work than those who do not. As a result, the time spent between jobs (and before the first job) will increase and measured unemployment rates will rise, even if underlying labor market conditions are the same in both cases.

Social Support

The above cited quotation by Marianne Hill seems to support this interpretation of the data. In addition, a recent study based on a survey of a random sample of Puerto Rican workers[39] finds some evidence which is consistent with this view. However, the mere fact that higher unemployment rates are associated with higher levels of transfer payments in the sample is not decisive, since people with lower incomes will find it easier to qualify for these programs in any case. Therefore, the links between unemployment rates, social support programs and family income remain very much open to further research.

iii. The Minimum Wage

In contrast to the two points previously mentioned, there is strong evidence that the minimum wage increases in Puerto Rico have strongly affected local production and employment. Since many of the economic activities related to renewable resources are labor intensive, these would be especially affected by minimum wage changes.

First of all, there is substantial evidence from the U.S. experience that minimum wage increases reduce the amount of labor which employers want to hire, other things being equal. Dozens of empirical studies support this conclusion, and there is no reason to believe that the results would be different for Puerto Rico, even though empirical material is not available in the same depth as on the mainland.

Social Support

One early study of the minimum wage in industry, by Reynolds and Gregory,[40] found circumstantial evidence that increases in the minimum were important in many industrial sectors in Puerto Rico. Rising wages have been largely responsible for the decline of resource - based industries in Puerto Rico, not to mention the decline of the agricultural sector.

More recently, Carlos Santiago used modern ARIMA techniqes and revised employment data not previously available to study the effects of the minimum wage on employment and unemployment in Puerto Rico. Though his results tend to confound minimum wage and other social support programs because of the timing of the effects involved, he concluded tentatively that minimum wage policy was important, particularly in raising unemployment.

> "There are some parallels between the results of this study and those of Reynolds and Gregory (1965). . .this paper suggests that disemployment effects continue to be small (being offset somewhat by advances in labor productivity). On the other hand, a major difference from the earlier work is that unemployment effects appear much larger than in the past. The explanation, of course, is that standards of living have increased on the island, and the relative advantages of external migration have diminished given the network of social programs that have been created on the island."[41]

In conclusion, it would appear that the tendency of the social support programs to increase unemployment rates on the island, while important in general, has little relation to renewable resources. The most important effect of social support programs on the renewable resource - based industries has been the rise in labor costs due to the Federal minimum wage.

CHAPTER V: SECTIONS 934 AND 936 RELATED TO RENEWABLE RESOURCE DEVELOPMENT

A. Introduction

As Puerto Rico has a tax system which is largely independent of the U.S., tax incentives for particular sectors or types of production are normally a part of local rather than national policy. One exception, however, is Section 936 of the U.S. Internal Revenue Code (for Puerto Rico) and Section 934 (for the U.S. Virgin Islands). They provide Federal tax exemption for the profits of subsidiaries of U.S. firms operating in these U.S. Territories. Particularly in Puerto Rico, this tax exemption has been used to attract a large amount of outside investment, and has greatly stimulated economic development since World War II.

There are two principal ways in which these Federal tax incentives affect renewable resources. One is by stimulating industrial development. This applies both to Puerto Rico and to the Virgin Islands. The other is by providing a source of low-cost credit, as accumulated profits are reinvested by the companies tax free in the local financial system. This incentive applies only to Puerto Rico. We will discuss each of these incentives in turn.

B. Incentives for Manufacturing Investment

Sections 934 and 936 have been major incentives for manufacturing investment in Puerto Rico and the Virgin Islands. Part of this manufacturing development has been in areas related to renewable resources. The importance of these industries shows up in Tables 21 and 22. Table 21 shows data on 936 manufacturing in Puerto Rico for industries related to renewable resources. As can be seen from the table, these industries accounted for only 30 percent of total 936 employment and a bit over 20 percent of 936 payroll in 1982. Even when all manufacturing -- including both local and 936 companies -- is included as in Table 21, the resource based industries do not make up a large amount of the total.

In the past these industries were more important in the overall manufacturing sector, but their share of employment and production has declined. Many of these industry groups are labor intensive, and have suffered from the rapid postwar rise in labor costs which we discussed in the previous chapter. The 936 companies have moved increasingly toward the high - technology areas of production in recent years. Much of the resource - based activity takes place in local firms, as one can see by a careful comparison of Tables 21 and 22.

C. Industrialization and the Local Resource Base

Many of these industries, although oriented towards processing of agriculture, fishing and forestry products, do not make extensive use of local materials. For example, bamboo furniture manufactured in Puerto Rico actually uses wood imported from abroad.[42] Even food processing sometimes uses imported inputs.

Table 20

EMPLOYMENT AND COMPENSATION IN 936 INDUSTRIES RELATED TO RENEWABLE RESOURCES

Industry Group	1982 Employment (000)	1982 Compensation ($000)
Food Processing	5.9	91.1
Textiles	1.2	11.0
Apparel	14.0	103.7
Leather	3.5	32.3
Total (Resource Inds)	24.6	238.1
Total (All 936)	81.2	1143.3

Source: U.S. Treasury, Fifth 936 Report

Table 22

EMPLOYMENT BY SECTOR, 1940-1984, PUERTO RICO
(000)

Sector	1940	1950	1960	1965	1970	1975	1980	1984 Prelim
AGRICULTURE, Total	229	214	124	107	68	47	40	38
Sugar cane	124	87	45	32	18	9	4	2
Coffee	26	22	23	21	12	9	8	13
Tobacco	16	20	9	12	2	(B)	(B)	(B)
Other products	61	85	47	42	36	28	26	23
FORESTS/FISHERIES	(B)	2	(B)	(B)	(B)	(B)	(B_	(B)
MANUFACTURING, Total	101	101	91	112	132	130	143	142
Sugar	20	11	8	7	7	4	4	2
Tobacco	6	6	6	9	5	6	2	1
Textiles/related	17	12	22	29	37	32	33	31
Alcoholic beverages	(B)	(B)	2	3	3	3	2	2
Home Needlework	45	51	10	6	(B)	(B)	(B)	(B)
Other products	13	24	43	58	80	85	102	106
MINING/CONSTRUCTION	16	27	45	58	76	65	44	34
BUSINESS, Total	54	89	97	109	128	134	138	145
Wholesale	6	7	9	13	13	17	17	19
Retail	48	82	88	96	115	117	121	126
FINANCE, INS, REAL EST	2	3	6	9	13	17	21	22
PUBLIC UTILITIES, Total	20	28	39	39	45	49	47	41
Transportation	17	23	27	25	27	26	25	22
Communications	1	(B)	4	4	6	7	8	8
Other utilities	2	5	8	10	12	14	14	11
DOMESTIC SERVICE	43	31	18	17	15	9	6	6
OTHER SERVICES	30	46	57	73	101	105	129	134
PUBLIC ADMINISTRATION	13	45	62	77	106	143	154	177

(B) = Less than 2000

Thus, the effect of this large industrial base on local natural resources is not as extensive as one might at first believe. Indeed, the industrialization of the island has in some respects lessened the burden of a very dense population on a small resource base by making it possible to support a high level of economic activity without heavy claims on the local resource base. In this sense, at least, the program of Federal tax exemption for industry has been well suited to the development needs of the islands.

On the other hand, industrialization has led to the heavy use of scarce resources. Urbanization, brought on by rapid economic growth, has taken large amounts of agricultural land out of use in Puerto Rico.[43] The pharmaceutical industries which have located in large numbers on the island in recent years have been heavy users of water. Recently a number of examples have been found of ground water contaminated by industrial wastes in Puerto Rico.[44] And most important, the island's waste water treatment facilities have been unable to keep up with the demands of rapid economic growth and still keep up with EPA guidelines. This problem, which has led to major legal conflicts between the Puerto Rican government and the Federal EPA, was discussed in an earlier section of this study.[45]

D. Credit Programs

(i) Direct Federal Loan Programs

The Federal Government has supplied substantial amounts of funds for direct farm lending in Puerto Rico. During FY 1984 the various loans affecting renewable resource development totaled $8.2 million in Puerto Rico and $3.7 million in the U.S. Virgin Islands. And when loan guarantees are included, the totals become much larger: $128.6 million in Puerto Rico and $6.2 million in the Virgin Islands. These figures appear in Summary Table 2 on page 11 of this report.

(ii) Private Sector Credit

Despite substantial Federal lending, much of the credit going to agriculture in Puerto Rico and the Virgin Islands comes from the private sector. But this credit is affected by Federal programs. Especially important in this area is Section 936 in Puerto Rico.

Besides exempting Puerto Rican profits from Federal taxes, Section 936 also permits companies operating there to invest their profits in local banks, thereby avoiding taxes on the interest from these deposits, as long as the funds are used for economic development purposes. The basic goal of this legislation is to lower the cost of credit entering the financial system, thereby encouraging investment in productive activities, including agriculture. No similar provision applies to the Virgin Islands.

(iii) Effectiveness of the Programs

Wide differences of opinion exist as to the effectiveness of these programs in stimulating investment. The U.S. Treasury, in its Annual Reports on Section 936, has consistently held that they have attracted more funds than the economies of the islands can productively absorb, and that their effects on interest rates and real investment have been relatively minor.[46]he Puerto Rican government, on the other hand, has consistently stressed the value of these provisions for long term investment.[47] And the local government may be correct in pointing out many benefits from this part of the program. Nevertheless, these have not usually gone to the renewable resource industries such as farming, fishing and forestry.

There are several reasons why such large credit programs did not have greater effects in these areas. First, ample credit programs, although beneficial to farmers, cannot overcome other obstacles to growth such as high labor costs (relative to the surrounding islands), backward technology, and lack of marketing expertise.

Second, it is important to keep in mind the basic character of the agricultural sector in Puerto Rico and the Virgin Islands, as outlined in an earlier chapter. Most farms are small family operations run by older people. These characteristics often prevent local farmers (or fishermen) from qualifying for commercial bank loans. And even if they could qualify, their ability to absorb these susbsidized loan funds on a large scale would be very limited, due to the very nature of their businesses.

The activities of the Bank of America in Puerto Rico represent one example of this phenomenon. This bank was permitted to establish operations on the island in the late 1970's, strictly as a wholesale banking operation. It was understood that the bank would accumulate funds from the 936 companies and channel a large part of its commercial lending to the agricultural sector. However, in reality the bank has done very little agricultural lending, in large part because so few borrowers in that sectors could compete successfully with other types of borrowers for commercial loans.[48]

Still, promoting agricultural development as a strictly business activity has not always been the main purpose of these Federal programs. The Federal Study on Puerto Rico makes this point clearly when it says of direct loan programs,

> "Few Federal investment programs supply funds only for economically productive ends. For example, although Agriculture Department loans are used for equipment and livestock purchases and for production facilities, these loans also serve such socially oriented ends as debt refinancing, family subsistence needs, housing and paying for property taxes and insurance premiums. Even with business development activities, there are usually some clear social purposes for which a degree of economic productivity will be sacrificed."[49]

In general, however, commercial banks are not willing or able to shift their lending policies toward socially productive ends. Thus, it is unlikely that Federal programs which rely heavily on market forces will have substantial effects in developing this particular groups of industries, even though they may have many other socially desirable results.

(iii) Local government programs

In practice, the local government has been compelled to meet the lack of agricultural credit from the Federal government and from the private sector. Through the Farm Credit Administration, a public corporation, the Puerto Rican government has financed considerable agricultural activity, including a large, experimental vegetable growing area on the South Coast near Santa Isabel. The government also subsidizes working capital for small farm operators by providing some agricultural inputs as well as a limited subsidy for farm wages.

Indirectly, the credit - related provisions of Section 936 also support these activities. Puerto Rican public debt is one of the assets in which 936 funds can be invested. And commercial banks lending 936 funds are required to make available ten percent of these to the Government Development Bank, which is the principal lending arm of the local government. These deposits now total approximately $700 million. In this way, Section 936 indirectly strengthens the ability of the Puerto Rican government to undertake agricultural lending programs of this kind.[50]

With the approval of USDA, the Puerto Rican government also used some funds from the Food Stamp program, after it was turned into a block grant in 1982, for a revolving loan fund to finance a variety of programs related to local food production. However, Federal auditors subsequently criticized the administration of this program, and few Federal dollars are currently being directed into it.

Another innovative program worth mentioning has recently been started by the Farm Credit Bank of Baltimore. It sold special securities in the 936 market which will be used specifically to back farm loans undertaken by that bank. The result will be a reduction of approximately 1.5 percent in the interest rates which farmers must pay for credit.[51] As the program is new, it is too early to evaluate it. Unlike the other programs mentioned here, however, this one is strictly undertaken by the private sector.

It should nevertheless be clear that the variety of local government, private sector and Federal government programs for farm credit have not been enough to offset the basic economic forces leading to a decline in agriculture in Puerto Rico and the Virgin Islands. Many of these were mentioned earlier in the section on agriculture. They are relatively high wages, little protection from outside imports, backward technology and a lack of stimulus for technological change. In addition, a ceiling of 500 acres on farm size, imposed at the turn of the century to break up large landholdings, makes it difficult to realize economies of large scale production. The long - term tendency to declining farm employment appears clearly in the earlier section.

CHAPTER VI

TRADE POLICY AND THE CARIBBEAN BASIN INITIATIVE RELATED TO RENEWABLE RESOURCE DEVELOPMENT

A. Introduction

U.S. trade policy affects Puerto Rico and the Virgin Islands in highly complex ways. After all, trade policy has various effects on prices, production, wages, and many other economic variables.

Furthermore, Congress has arranged its trade policies towards its two Caribbean territories in such a way that they are in many ways mirror images of each other. Puerto Rico has an autonomous tax system, and it has used this to develop fiscal incentives to attract mainland industry. But Puerto Rico falls inside U.S. Customs territory, and it is subject to all national customs duties and trade regulations. The only exception is that the island is entitled to levy a special excise tax on imported coffee, as we explained in the section on agriculture. Tourism has always been a relatively unimportant part of Puerto Rico's economy, and except for the tax deduction for conventions it enjoys no special incentives from the U.S. In any case, that sector has been on the decline in Puerto Rico in recent years.

The Virgin Islands, on the other hand, has relatively little fiscal autonomy. The Naval Appropriations Act of 1922 includes a provision which requires the Virgin Islands government to apply the same income tax laws in effect in the United States. And although the Virgin Islands does have a Federal tax exemption priviledge for industry which is similar to Section 936 in Puerto Rico, that Territory has not attracted large amounts of outside investment. According to the Fifth 936 Report of the U.S. Treasury, the Virgin Islands in 1982 had only 40 firms under Section 934, with total receipts of approximately $5 billion. Eight chemical firms accounted for almost all of these sales.

On the other hand, the Virgin Islands is not considered part of U.S. customs territory, and has substantially more control over its own customs duties than Puerto Rico. It has been highly successful in creating a diverse shopping area with many imported products sold free of customs duties. This, together with advertising campaigns and other local policies, has created a large tourism industry which has formed the cornerstone of the island's economic growth. This, in turn, has been primarily responsible for substantial hotel investment and considerable population growth, with incalculable effects on the islands' renewable resources.

In short, the Virgin Islands and Puerto Rico have developed along very different lines, due to differences in the types of incentives which Congress has made available to them. But trade incentives have been much more important for the Virgin Islands than for Puerto Rico. Because of the complexity of the issues involved here, we will restrict our discussion mainly to the

Caribbean Basin Initiative, devoting only brief coverage to other aspects of U.S. trade policy.

B. Definition and Explanation of the CBI

The Caribbean Basin Initiative is a plan to stimulate private sector development in a number of Caribbean countries by opening up U.S. markets to their exports. Congress has eliminated tariffs on imports into the U.S. from the participating countries without requiring any offsetting concessions on their part. The U.S. convention tax deduction was also extended to participating countries as a way of encouraging tourism, provided these countries complied with certain requirements for reporting banking transactions.

Of course, all Caribbean countries cannot participate in the program. Table 23 lists the countries which the President has designated as beneficiaries as of the date of this study. Table 24 provides basic information about those jurisdictions, with similar data for Puerto Rico and the Virgin Islands, for a comparison of their relative conditions. In terms of population, Puerto Rico and the Virgin Islands appear relatively unimportant in the region, having less than ten percent of the combined population of all the participating countries. Still, the per capita income of Puerto Rico and the Virgin islands is higher than that of any participating country for which data is available, so much so that the total gross product for Puerto Rico was larger than that of the combined beneficiary countries

Table 23

BENEFICIARY COUNTRIES
Caribbean Basin Economic Recovery Act (CBERA)

A. Countries included in Proclamation 5133, promulgated on 30 November 1983 and published in the Federal Register on Monday, 5 December 1983, at page 54453:

1. Barbados
2. Costa Rica
3. Dominica
4. Dominican Republic
5. Jamaica
6. Netherlands Antilles
7. Panama
8. Saint Christopher/Nevis
9. Saint Lucia
10. Saint Vincent and the Grenadines
11. Trinidad and Tobago

B. Countries included in Proclamation 5142, promulgated on 29 December 1983 and published in the Federal Register on Wednesday, 4 Jabuary 1984, at page 341:

12. Antigua and Barbuda
13. Belize
14. El Salvador
15. Grenada
16. Guatemala
17. Haiti
18. Honduras
19. Monserrat
20. Virgin Islands, British

Notes: 1. Netherlands Antilles includes Aruba, Bonaire, Curacao and Sint Maarten.

2. St Kitts-Nevis does not include Anguilla.

3. Belize was formerly British Honduras.

Source: Federal Register, dates indicated

Table 24

BASIC INFORMATION ABOUT CBI BENEFICIARY COUNTRIES

Country or Area	Land Area Sq Miles	Population (000) 1970	1982	GrossDomProd-1974 Total $000,000	$ Per Capita
CENTRAL AMERICA	151305	14328	21248	9323	651
Belize	8867	119	171	93	682
Costa Rica	19650	1710	2319	1660	863
El Salvador	8260	3440	5082	1577	405
Guatemala	42042	5090	7704	3161	535
Honduras	43277	2530	3957	997	372
Panama	29209	1439	2015	1835	1133
GREATER ANTILLES	33762	11010	14603	6463	587
Dominican Republic	18816	4240	6247	2923	641
Haiti	10714	4800	6103	733	162
Jamaica	4232	1970	2253	2807	1396
LESSER ANTILLES	3689	2067	2339	na	na
Barbados	166	257	269	311	1297
Nthrlands Antilles	390	217	267	na	na
Trinidad/Tobago	1980	1060	1202	1927	1801
Windwrd/Leewrd Is	1153	533	601	na	na
Antigua/Barbuda	113	63	79	na	na
Dominica	290	75	86	na	na
Grenada	133	106	113	na	na
Montserrat	32	15	11	na	na
St Kitts/Nevis	138	57	77	na	na
St Lucia	238	112	122	na	na
StVincent/Grnadin	150	96	99	na	na
Virgin Is(UK)	59	9	14	na	na
TOTAL CBI	188756	27405	38190	NA	NA
Puerto Rico	3435	2712	3259	8208	2709
US Virgin Islands	132	63	116	na	na

Sources: United Nations Environmental Program: Caribbean Environmental Programme Action Plan, 1979
United Nations Food and Agriculture Organization: Forestry and Fisheries Reports, 1982

in Central America -- as of the date when these figures were collected. Puerto Rico and the Virgin Islands also have other characteristics which go along with their higher incomes per capita: higher wage rates, better infrastructure, and a greater variety of skilled labor.

To qualify for duty-free CBI treatment under the CBI program, goods must be "substantially transformed" in the Caribbean region. Specifically, at least 35 percent of their final value must be produced there. To prevent damage to U.S. industries, a substantial number of products were excluded from the CBI. These include a number of items which form a substantial part of the total manufacturing production of some of these countries. Likewise, with the current surge of protectionist sentiment in the United States, there have been several moves in Congress to cut off CBI benefits retroactively for products which have successfully penetrated the U.S. market. All of these modifications to the CBI legislation serve to weaken the investment incentives which the program was intended to generate.

It is important to remember as well that the CBI does not subsidize trade among various countries within the region; it only encourages exports from each participating country to the U.S. Therefore, it will have relatively little effect on trade patterns within the region. Furthermore, to take full advantage of the trade provisions of the legislation, many of the countries in the region will have to greatly strengthen their capacities to attract private investors. Likewise, a variety of other areas will need to be built up over the long term, including infrastructure and business education for local entrepreneurs.

The early assessments of the CBI, at least those coming our of the Caribbean region, indicate that its results have not been so substantial as had been hoped for originally when the program was being planned. Jamaica, one of the countries which was expected to benefit most from the CBI, has fallen into a severe economic crisis. And exports from the region to the U.S. market have actually declined during the early part of the program, according to recent press reports.

Although this does not necessarily indicate that the program has been counterproductive, it does suggest that it is not providing strong enough medicine to deal effectively with the severe economic problems facing many countries in the region. Perhaps the greatest success of the CBI up to now has been to focus the attention of U.S. businesspeople for the first time on the Caribbean region, which had previously been largely ignored as a potential investment site.

C. Effects on Renewable Resource Industries .

How will the CBI affect the renewable resource industries in Puerto Rico and the Virgin Islands? The direct, short-run effects will be relatively minor. One of the most widely discussed possibilities when the program was first announced was that competition from the lower wage Caribbean islands would further weaken the already precarious agricultural sector in the U.S. islands. In fact, this has not happened to any great extent. Many of the potential exports from the rest of the Caribbean were already entering duty-free under the CSP program (described below) when the CBI began, or were subject to very low tariff duties. There was a serious potential threat to Puerto Rico's tuna-canning industry, but this problem disappeared when Congress excluded canned tuna from tariff benefits under the CBI.

Perhaps the greatest effect of the CBI on natural resource based industries has been in the area of rum-production. Here, Puerto Rico in particular has lost some of its U.S. market share to the other Caribbean islands, as the Initiative sharply reduced U.S. tariff protection for that product. However, Puerto Rico and the Virgin Islands have for years imported much of the sugar which is used to produce their rums because of the high costs of growing and harvesting sugar in the Territories. Therefore, the change will have little effect on these jurisdictions except in the manufacturing phase. The declining sugar industries in other Caribbean countries will benefit on balance, however.

There are some other possible complementarities in the use of natural resources between the U.S. Territories, on the one hand, and the rest of the Caribbean Basin on the other. The CBI will help at least to some degree in developing these opportunities. One possible contribution of the program lies in the possibility of stimulating "twin plant" production between the Territories and other countries of the region.

This term refers to production sharing between the U.S. Territories and other Caribbean nations, designed to take advantage of the economic differences between the U.S. Territories and the rest of the Caribbean region, which we described earlier. In a "twin plant" arrangement, the labor intensive phases of production are carried out in the low-wage Caribbean islands and the skill-intensive phases in Puerto Rico or the Virgin Islands. Under the CBI legislation, the Puerto Rican portion of any value added in the Caribbean region can count toward the thirty five percent which is required to qualify the product for duty-free admission to the U.S. Even if the Puerto Rican phase of the manufacturing process comes at the end of the chain, a special provision was passed by Congress to allow it to count towards meeting the value added requirement of the CBI, provided that it was performed in a special bonded warehouse. But because the Virgin Islands is not part of U.S. customs Territory, this special provision could not be extended to that area as well.

There have been two recent examples of twin plant operations involving natural resource based industries. One of these is a small program to import passion fruit from Dominica for processing into fruit juice in Puerto Rico. Another, much larger project would construct five refineries for sugar - based alcohol in Puerto Rico, using old sugar refineries which have been closed for a number of years. The raw sugar would come from other countries in the Caribbean region, and the final product would be mostly shipped to the U.S. for use as a gasoline additive. It seems likely that this project would have the potential of creating hundreds of jobs, both in Puerto Rico and in the sugar industries of other Caribbean islands.

It should be made clear, nevertheless, that the CBI by itself could have no role in attracting the production to Puerto Rico. Congress specifically excluded this type of production from counting towards the value added requirement of the CBI; if it meets this requirement, it will be due to labor - intensive production in other islands. What Puerto Rico can contribute to such a project would be its superior infrastructure together with the tax benefits of Section 936 of the U.S. Internal Revenue Code.

The twin plant idea has received tremendous publicity since the CBI began, especially in recent weeks and months as the Hernandez Colon administration in Puerto Rico has promoted the concept heavily. And while it may indeed be useful in helping some labor - intensive industries to survive, the applicability of the concept is limited. So far, most twin plant arrangements have been oriented toward assembly and finishing of components brought in from other areas, mainly in the electronics industry. Indeed, economic considerations involving management coordination, transportation cost and inventory control probably limit the applicability of the concept primarily to this type of operation.

It has been estimated that there are no more than two dozen twin plants operating today in Puerto Rico. The Hernandez Colon administration has been able to obtain commitments from an equal number of companies to build twin plants in the future. But these promises are subject to the condition that Congress leave Section 936 of the U.S. internal revenue code unchanged for the time being. And as this is being written, Congressional intentions in this area remain unclear.

D. Other Aspects of U.S. Trade Policy

(i) Opening up U.S. Markets to Third World Exports

The Caribbean Basin Initiative is only one of several programs which Congress has enacted during the past several years to open up U.S. markets to third world countries, including those in the Caribbean. One of these older programs is the 806/807 offshore assembly legislation. This permits tariff reductions only on the value added to U.S. inputs in offshore areas, and allows only assembly rather than "substantial transformation" to take place offshore. Another existing program which runs parallel to the CBI is the GSP (Generalized System of Preferences) which provides duty-free access to the U.S. market for a somewhat narrower range of products than does the CBI. The countries which participate in the CBI are also eligible for GSP treatment.

In general, in setting up these programs Congress has been careful to protect mainland U.S. agriculture, carefully excluding most temperate zone agricultural products from the tariff reductions. This has not been the case, however, for tropical products. It would appear that little consideration was given to the effects which trade liberalization might have on the agricultural sector in the Territories, especially when combined with a phasing in of the U.S. minimum wage and a tradition - bound agricultural work force which tends to resist rapid changes in technology. On balance, then, the U.S. policy of opening up our markets to trade from other developing countries, combined with these other factors, accelerated the decline of agricultural activity in the Caribbean territories.

(ii) The Relatively High Value of the U.S. Dollar

Due to the combination of monetary and fiscal policies pursued by the Reagan administration, the dollar has maintained a relatively high exchange rate in recent years. This policy has also had substantial effects on renewable resource industries in the islands. A number of industries in Puerto Rico, including particularly the cement and beer industries, have been affected adversely by rising imports.

It is also very possible that the islands could have exported more renewable resource products to other countries, particularly those in the Caribbean Basin, had the dollar exchange rate remained at its historical levels. Table 25, on the next page, shows Puerto Rico's shipments of processed renewable resource products according to the most recent census of

Table 25

SHIPMENTS OF PROCESSED RENEWABLE RESOURCE PRODUCTS FROM PUERTO RICO 1982

($000,000)

Industry Group		Number of	Total		Destination			
SIC	Identity	Estab.	Shipped	P.R.	U.S.	US VI	Foreign	
							Total	CBI
	Total	1345	15457	2253	8989	23	879	120
20	Food, Total	166	2298	765	768	7	27	(D)
201	Meat Prod.	16	97	74	0	0	0	0
202	Dairy Prod.	14	228	79	(D)	0	(D)	(D)
203	Fruit/Veg.	26	154	86	20	1	(D)	(D)
204	Grain Mill	12	226	182	(D)	(D)	0	0
205	Bakery Prod	37	204	59	2	2	(D)	0
206	Sugar/Confe	8	88	15	61	(D)	(D)	(D)
207	Fats/oils	2	(D)	(D)	(D_	0	0	0
208	Beverages	23	653	223	156	1	22	(D)
209	Miscellaneo	28	(D)	(D)	(D)	(D)	(D)	(D)
2091	Seafood	7	509	11	493	0	(D)	(D)
2095	Roasted Coffee	10	(D)	(D)	(D)	0	0	0
26	Paper prod.	26	109	37	(D)	0	(D)	(D)
287	Agr.Chemicals	6	(D)	(D)	(D)	0	(D)	(D)

Source: U.S. Department of Commerce, Bureau of the Census
Census of Manufactures, 1982, Table 4: Value of Shipments for Industrial Groups and Industries by Country of Destination for Establishments with 10 Employees or more, 198

industry. While the vast majority went to the U.S. mainland, it is surprising how much went to foreign destinations, including Central America and the Caribbean. Provided that Section 936 remains in place and the Reagan administration follows through on its declared intention to lower the international value of the dollar, these shipments can be expected to increase substantially in the future.

CHAPTER VII:

SUMMARY AND POSSIBLE CHANGES IN U.S. POLICY

What patterns can we find in this complex web of Federal policies and interventions? Several general points are worth making. First, some types of programs have been more effective than others. The most useful seem to have been incentives related to the transfer of mainland technology and knowhow in specialized areas. For example, the drawing of soil maps, the carrying out of groundwater studies, and similar types of activities have undoubtedly been very constructive.

Likewise, Federal regulations concerning water and air pollution have had a positive effect in preserving the local ecology under conditions of rapid economic growth. Industrialization has been much more destructive of the natural environment in other rapidly developing countries which did not have similar protection. And this is true despite the fact that Federal air and water regulations were not always sufficiently flexible to take into account the important differences between tropical islands and large land areas in most of the U.S. Nor were they applied soon enough to prevent contamination of the local ground water, pollution of reservoirs used as sources of drinking water, or other types of ecological damage by industry.

Other programs, such as those intended to provide subsidized credit, have not worked so well as had been originally hoped. Massive programs of social intervention, such as transfer payments and the Federal minimum wage, have had unintended side effects in raising unemployment, and may have accelerated the decline of some of the more labor intensive industries such as cigar wrapping, hand embroidery and subsistence agriculture. And many types of public health and social support programs have undoubtedly increased the local population faster than would otherwise have occurred. However, they have helped the island Territories to avoid the extreme ecological damage which dense populations have caused in much poorer islands such as Haiti, by reducing the direct dependence of the poorer segments of the population on the land. The fact that even the poorest residents can afford bottled gas and electricity instead of having to gather firewood, for example, has undoubtedly made a major difference in the ecological development of the islands.

Above all, what stands out in Federal policy towards renewable resources is a failure of comprehensive planning, coordination and flexibility. Though the Federal government is very good at transmitting specific technolgies already developed and in use within the U.S. context, it is very weak in anticipating side effects from programs which are applied outside the usual U.S. economic and social context. There is a strong tendency to ignore the interconnections between different types of social and economic policies, or the difficulties in applying the same type of policy in different social, economic and physical settings. The impulse instead is to apply to the Territories whatever solution may be currently in vogue on the U.S. mainland.

One of the best examples which comes to mind is the proposed elimination of Sections 936 and 934 by the U.S. Treasury. While usually thought of in connection with U.S. tax reform and the tax treatment of high - technology industries, the changes proposed by Treasury would clearly affect labor - intensive, resource - based industries as well. And the effect on the fiscal position of the Puerto Rican and Virgin Islands governments would be so far reaching that it would be much more difficult for them to deal with emerging environmental problems in their own right. The side effects of such a change would ripple out into all aspects of the local society, but it is doubtful that these factors were taken into account by those who conceived the proposed modifications.

In other cases, the fragmented nature of Federal policy toward the Territories has sometimes produced sets of policies which have mutually inconsistent effects. In the area of social support programs, one example would be the simultaneous application of sugar price supports, which reduced the demand for sugar on the U.S. mainland, and the U.S. minimum wage in Puerto Rico, which raised the cost of local sugar production. Both of these measures, along with the opening up of U.S. markets to imports of tropical agricultural agricultural products, helped to increase unemployment on the islands; only large scale outmigration to the mainland prevented a much worse situation from developing. Yet at the same time, Congress was undertaking the task of raising the standard of living on the islands through massive social support programs.

Clearly there was an element of conflict among these different interventions. Other policies have been inappropriate to the special conditions prevailing in the Territories. Several examples are given in the inventory of incentive programs in Chapters II and III.

There is no doubt that Federal policy has been generally well - intentioned, and that a great many positive achievements can be recorded. Nevertheless, improvements in the Federal policymaking process toward the Territories are badly needed. A greater concern by the Federal government about the long - term environmental effects of its programs would certainly help. Beyond this, some way is needed to coordinate the large number of Federal programs affecting Puerto Rico and the Virgin Islands according to some kind of consistent pattern, with long - term goals in mind. A special White House Task Force was not able to achieve this for Puerto Rico, nor was a massive Federal study of the island's problems completed more than five years ago. Even less has been attempted, and less accomplished, in dealing with the problems of the Virgin Islands.

Since Congress ultimately decides Federal policy toward the Territories, only a reform of the decisionmaking process within that body will ultimately resolve these problems. A joint Congressional Committee on Territorial problems, with its own staff support, might at least make a beginning towards resolving these difficulties. Perhaps some other organizational structure would be more in accord with the requirements of Congress. But some kind of overall policy review and coordination is needed if environmental and resource policy toward the Territories is to emerge from the tangle of conflicting and overlapping decsions which are now the rule.

LIST OF ACRONYMS

AMS	Agricultural Marketing Service
CCC	Commodity Credity Corporation
CEIP	Coastal Energy Impact Program (part of NOAA)
CFMC	Caribbean Fisheries Management Council
CODREMAR	Corporation for the Development of Marine, Lacustrine, and Fluvial Resources (in DNR)
CSRS	Cooperative State Research Service (U.S. Department of Agriculture)
CZM	Coastal Zone Management
DNR	Puerto Rico Department of Natural Resources
DOT	U.S. Department of Transportation
EDA	U.S. Economic Development Administration
EPA	U.S. Environmental Protection Agency
EQB	Puerto Rico Environmental Quality Board
ESE	Elementary and Secondary Education (U.S. Department of Education)
ETA	Employment and Training Administration (of U.S. Department of Labor)
FEMA	Federal Emergency Management Administration
FHWA	Federal Highway Administration
FmHA	U.S. Farmers' Home Administration
FS	U.S. Forest Service
FWS	Fish and Wildlife Service (U.S. Dept. of Interior)
HHS	U.S. Department of Health and Human Services
HUD	U.S. Department of Housing and Urban Development

Acronyms

NAP	Puerto Rico Nutrition Assistance Program (island version of U.S. food stamp program)
NOAA	U.S. National Oceanic and Atmospheric Administration
NMFS	U.S. National Marine Fisheries Service
NPS	National Park Service (U.S. Dept. of Interior)
OPEC	Organization of Petroleum Exporting Countries
OSHA	Occupational Safety and Health Administration
OTA	U.S. Office of Technology Assessment
PRASA	Puerto Rico Acueduct and Sewer Authority
PREPA	Puerto Rico Electric Power Authority
REA	U.S. Ruraal Electrification Administration
SBA	Small Business Administration
SCS	U.S. Soil Conservation Service
UDAG	Urban Development Action Grants (from HUD)
UMTA	Urban Mass Transit Administration (of U.S. Department of Transportation)
UPR	University of Puerto Rico
USEDA	U.S. Economic Development Administration
USFS	U.S. Forest Service
VA	U.S. Veterans' Administration
WAPA	Virgin Islands Water and Power Authority
WRC	Puerto Rico Water Resources Council

FOOTNOTES

(Citations refer to authors in the Bibliography)

1. See W.D. Deerland or Little and Woodbury. Cited in Richard A. Birdsey and Peter L. Weaver.

2. For more detailed descriptions of the colonial arrangements summarized in this section, see Raymond Carr, ch. 1, pp. 17 *et. seq.*; Gordon Lewis, chs. 1-2; or James Bough and Roy Macridis.

3. Information on land area and population for each Territory came from the 1980 Census of Population. The calculations of densities were made by the authors.

4. This point is discussed in more detail, with bibliographic references, in chpater VII.

5. See C.E. Chardon, *et. al.*. The following page references refer to discussions of various crops: citurs, pp. 42-48; cotton, pp. 62-63; sugar, pp. 11-27; coffe, pp. 33-34; tobacco, pp. 49-54.

6. Personal communication from Carlos Lopez, Secretary of Agriculture under Governor Romero - Barcelo. This provision was included in the Jones Act of 1917. For a general description of this act, not mentioning tobacco, see Raymond Carr, pp. 52-56.

7. U.S. Department of Commerce, *Kreps Report*, v. II, p. 294. This source also gives a good summary of the status of other major crops in Puerto Rico as of the late 1970's.

8. See Bosco Esteruelas for one example of recent comments on this topic in the press. For an older discussion which covers the institutional arrangements in the sugar market, but not the recent effects of artificial sweeteners, see Ilse Mintz, ch. 4.

9. Department of Natural Resources. Also, C.E. Chardon, *et. al.* pp. 5, 34, 42-44, 51, 144.

10. C.E. Chardon, *et. al.*.

11. Nathan Koenig.

12. Checchi and Company.

13. José Vicente Chandler.

Footnotes

14. Tahal Consulting Engineers, Ltd.

15. General fishery statistics from U.N. FAO, *Yearbook of Fishery Statistics: 1982.* Import statistics come from the Puerto Rico Planning Board.

16. The statistics on the tuna industry are presented in Economic Development Administration of Puerto Rico, "A Brief Statistical Look . . ."

17. Hilda Diaz-Soltero. Also, Tahal Consulting Engineers, Ltd., Appendix 17.

18. U.S. Department of Commerce, *Kreps Report*, v. 1, ch. 4 contains one such map. For another, see U.S. Geological Survey.

19. *Loc. cit.*

20. See Watson H. Monroe.

21. Department of Natural Resources (PR), "Coastal Flood Hazards . . ."

22. U.S. Department of Commerce, *Kreps Report*, v. 1, pp. 128-37.

23. See both references by the U.S. Army Corps of Engineers.

24. The original study has never been officially released and is difficult to obtain in practice. For a reasonably good summary from the local press, see Karen Lowe.

25. Department of Natural Resources (PR), *Resumen Ejecutivo . .*

26. Many articles on this subject have appeared recently in the local press. For example, see Beatriz Ruiz de la Mata and Rolf Olsen. The latter article is especially interesting because it describes the problems of applying the "Superfund" program in Puerto Rico, due to a lack of matching funds.

27. See Karen Lowe.

28. See A. Quiñones Calderon.

29. See Richard Cerilli and Eva Lizardi.

30. See Department of Natural Resources (PR) and Research Planning Institute, "Sensitivity of Coastal Environments . . ."

31. PRWRA and Westinghouse Electric Corp.

Footnotes

32. Development and Resources, Inc.

33. U.S. Department of Commerce, Kreps Report, v. 1, p. 160.

34. See Alan T. Udall, "Federal Funding under the Reagan Administration . . ."

35. U.S. Department of Commerce, Kreps Report, v. 1, Part II, ch. III: "Review of Differential Federal Program Treatment in Puerto Rico."

36. See Marianne T. Hill and Alan T. Udall.

37. See Lloyd Reynolds and Peter Gregory, ch. ?. Also, U.S. Department of Commerce, Kreps Report, v. 2, pp. 633-42.

38. See Marianne T. Hill, "Food Stamps or Checks? . . .", p. 13.

39. Arthur J. Mann and Marta Calás.

40. See Lloyd Reynolds and Peter Gregory, ch. ?.

41. See Carlos Santiago, pp. 17-18.

42. Personal communication from Dr. Frank Wadsworth, President of the Natural History Society of Puerto Rico.

43. U.S. Department of Commerce, Kreps Report, v.1, pp. 112-16.

44. See note 26.

45. See note 29.

46. See U.S. Treasury, pp. 68-72.

47. See Government Development Bank of Puerto Rico.

48. Personal communication from Bertram Finn, former chairman of the Financial Council of Puerto Rico.

49. U.S. Department of Commerce, Kreps Report, v.1, p. 205.

50. See Government Development Bank of Puerto Rico, p. 38.

51. Alan T. Udall, "The Proposal to Tax . . .", p. 13.

52. See U.S. Treasury, chs. 2 and 3.

53. The discussion of Virgin Islands tax incentives is based on U.S. Treasury, Appendix A.

Footnotes

54. See Alan T. Udall, "How Will the CBI . . ."

55. See Caribbean Marketing Overseas Corp., Section on "Mutual Cooperation", Part C. This summarizes a speech by Peter Johnson of Caribbean Central American Action which gives examples of these problems.

56. See Pulso Economico as one example of numerous articles in a similar vein appearing in the local press.

57. See Governor's Economic and Financial Council.

58. See John R. Stewart.

59. See Harold Lidin, "Isle Piledrives . . ." for one specific project mentioned in the text. For a more general overview, see Economic Development Administration (PR), "Survey of Puerto Rico Companies . . .". This latter study shows 24 projects as of July, 1985, creating 5,522 jobs in the whole Caribbean region.

60. As of this writing a House Committee has agreed to include some rather minor modifications to Section 936 as part of the tax reform bill. Formerly, the proposed modifications had been much greater. However, the reform bill also includes provisions for a 25% minimum tax and a 35% marginal tax on corporate profits. These would considerably blunt the effectiveness of Section 936. Also, the bill has yet to pass the full House, the Senate, or a conference committee.

61. See Harold Lidin, "Imports Steal . . ."

BIBLIOGRAPHY

Birdsey, Richard A. and Weaver, Peter L., "The Forest Resources of Puerto Rico", *USDA Forest Service Resource Bulletin* (1982:50-85), New Orleans: Southern Forest Experiment Station.

Bough, James A. and Macridis, Roy C., *Virgin Islands: America's Caribbean Outpost, The Evolution of Self Government*, Wakefield, MA: W.F. Williams Publishing Co., 1970

Caribbean Marketing Overseas Corporation, "Building a Framework of Successful Approaches to Investment Promotion", San Juan, P.R.: Caribbean Marketing Overseas, 1985. Summary of an AID Conference on private investment held in Dorado, P.R., May 19-22, 1985.

Carr, Raymond, *Puerto Rico: A Colonial Experiment*, New York: Random House, 1984, xxii + 477 pp. A Twentieth Century Fund Study.

Cerilli, Richard, "Feds Add 4 Plants to Ban on Sewage System Hookups", *Caribbean Business*, November 13, 1985, pp. 1-2, 38.

Chardon, C.E.; Menendez - Ramos, R.; and Fernandez - Garcia, R.; *Report of the Puerto Rico Policy Commission*, Washington, D.C.: June 14, 1934, 146 pp.

Checchi and Company, *The Role of Cooperatives in the Production and Marketing of Fruits and Vegetables in Puerto Rico*, Washington, D.C.: Checchi and Company, August, 1970. Sponsored by the U.S. Department of Commerce, Economic Developmnent Administration and the Puerto Rico Cooperative Development Administration.

Deerland, W.D., "Forest Regeneration in Puerto Rico," *Economic Geogrpahy* 5:369-81, 1929.

Department of Natural Resources (PR), "Coastal Flood Hazards and Responses in Puerto Rico: An Overview", San Juan: Department of Natural Resources, February, 1980.

Department of Natural Resources (PR), Area de Planificacion, *Resumen Ejecutivo: El Plan de Agua y el Reglamento de Agua*

Department of Natural Resources (PR) and Research Planning Institute, *Sensitivity of Coastal Environments and Wildlife to Spilled Oil: Puerto Rico, A Coastal Atlas*, San Juan, Department of Natural Resources, June, 1984.

Bibliography

Development and Resources, Inc., Economic Feasibility of the Toa Vaca Complex, December, 1970. Summarized in "Status Report - Toa Vaca Project", an anonymous interagency memo which appears to date from approximately 1972, and is in the authors' files.

Diaz-Soltero, Hilda, "The Department of Natural Resources: Forestry Program", Puerto Rico Business Review 8(4):2, April, 1983.

Economic Development Administration of Puerto Rico (Fomento), "A Brief Statistical Look at the Tuna Industry in Puerto Rico", Puerto Rico Business Review 7(6):4-7, June, 1982.

Economic Development Administration of Puerto Rico (Fomento), Office of Economic Research, "A Survey of Puerto Rico Companies with Complementary Projects in the Caribbean," San Juan: Economic Development Administration, mimeo, July, 1985.

Esteruelas, Bosco, "Alarma en la OEA por la Caída del Azúcar", El Nuevo Dia, March 17, 1985, p. 95.

Gonzalez Martinez, Alfredo, Los Efectos del Plan del Caribe del Presidente Reagan sobre la Economia de Puerto Rico, Mayaguez, P.R.: Uuniversity of Puerto Rico/Recinto Universitario de Mayaguez, Facultad de Artes y Ciencias, Departmento de Economia, mimeographed, 1982.

Government Development Bank of Puerto Rico, "The Impact of 936 Funds in the Financial Markets in Puerto Rico: A Complementary View of the 936 Issue," San Juan: Government Development Bank, mimeo, 1985. 51pp + Tables and Appendices.

Governor's Economic and Financial Council (PR), "A Brief Guide to the Effect of Present Tariff Rates on the Market for Puerto Rico's Agricultural Products," San Juan: mimeo, March, 1982.

Hill, Marianne T., "Food Stamps or Checks? The Nutrition Assistance Program in Puerto Rico", Puerto Rico Business Review 7(7-8): 3-13, 39, 1982 (July-August).

-----------------, "A Preliminary Assessment of the Economic Situation of Puerto Rico's Agriculture", Puerto Rico Business Review 8(5-6, Special Supplement): 1-17, 1983 (May).

Bibliography

---------------- and Udall, Alan T., "An Econometric Analysis of the Effects of Reductions in Food Stamp Benefits and Cash - Out in Puerto Rico," *The Review of Regional Studies* 14(3):25-33, Fall, 1984.

Koenig, Nathan, *A Comprehensive Agricultural Program for Puerto Rico*, Washington, D.C.: U.S. Government Printing Office, 1953.

Lewis, Gordon, *Puerto Rico: Freedom and Power in the Caribbean*, New York: Monthly Review Press, 1963, xii + 626 pp.

Lidin, Harold, "Imports Steal Jobs, Threaten Industry", *The San Juan Star*, May 12, 1985, p. B-1.

-------------, "Isle Piledrives to Spearhead Leadless Gas", *The San Juan Star*, September 11, 1985, p.1.

Little, E.L., Jr.; Woodbury, R.O.; and Wadsworth, F.H.; *Trees of Puerto Rico and the Virgin Islands*, v. II, Washington, D.C.: USDA Forest Service, 1974, 1024 pp. + illustrations. USDA Handbook Number 449.

Lizardi, Eva I., "AAA Pide un Aire a los Federales", *El Nuevo Dia*, November 9, 1985, p. 5

Lowe, Karen, "The Coming Water Wars", *The San Juan Star*, May 1, 1983, pp. 1, 20.

Mann, Arthur J. and Calás, Marta, "The Luxury Employment Hypothesis: Empirical Evidence from Puerto Rico," Paper presented at the Tenth Anniversary Conference of the Caribbean Studies Association, San Juan, May 29-June 1, 1985. Arthur Mann is Professor, College of Business Administration, UPR Rio Piedras.

Mintz, Ilse, *U.S. Import Quotas: Costs and Consequences*, Washington, D.C.: American Enterprise Institute, 1973, 85 pp. Domestic Affairs Study 10.

Monroe, Watson H., *Map Showing Landslides and Areas of Susceptibility to Landslides in Puerto Rico*, Map I 1148, USGS Miscellaneous Investigations Series, 1979.

Newman, Cy; Gwcry, E.L.; and Caso Brjarvinen; *Tropical Cyclones of the North Atlantic Ocean 1871-1980* (to 1984). Asheville, N.C.: University of North Carolina Press, 1978 (Rev. 1981), 173 pp.

Olsen, Rolf, "Funding Hinders Island's Toxic Cleanup", *The San Juan Star*, May 28, 1985, p. 18.

Bibliography

Ortiz Torres, Enrique, "Milk Production in Puerto Rico: A Profile", Puerto Rico Business Review 7(7-8):36-7 (July-August, 1982).

Puerto Rico Water Resources Authority and Westinghouse Electric Corp., Aguirre Power Plant Complex: Environmental Report, San Juan: PRWRA, April, 1972.

Pulso Economico, "Puerto Rico y el Caribe", El Reportero, September 3, 1985, p. 17.

Quiñones Calderon, A., "Inversión Millonaria en la AAA", El Nuevo Dia, May 17, 1985, p.4.

Reynolds, Lloyd and Gregory, Peter, Wages, Productivity and Industrialization in Puerto Rico, Homewood, Illinois: Richard D. Irwin, 1965.

Ruiz de la Mata, Beatriz, "Two Patillas Wells Contaminated; Residents Warned to Boil Water," The San Juan Star, April 25, 1985, pp. 1, 33.

Santiago, Carlos, "Closing the Gap: The Employment and Unemployment Effects of Minimum Wage Policy in Puerto Rico," Paper presented at the Tenth Annual Conference of the Caribbean Studies Association, San Juan, May 31-June 1, 1985. Carlos Santiago is Assistant Professor of Economics at Wayne State University, Detroit, Michigan.

Soltero, Hilda Diaz, "Forestry Program Encourages Timber Industry," Puerto Rico Business Review 8:4:2-7,16 (April, 1983).

Tahal Consulting Engineers, Ltd., Programa Estrategico para el Desarrollo Integrado del Sector Agropecuario en el Proximo Decenio, San Juan: Puerto Rico Department of Agriculture, February, 1984.

Stewart, John R., "The Twin Plant Concept in the Caribbean Basin", Puerto Rico Business Review 9(1-2):2 (January-February, 1984).

Udall, Alan T., "Federal Funding under the Reagan Administration: Background and Outlook", Puerto Rico Business Review (January - February, 1983), pp. 2-15, 35.

---------------, "How Will the CBI Affect Puerto Rico and the Caribbean?", Puerto Rico Business Review, 8(11):2-8 (November, 1983).

Bibliography

-------------, "The Proposal to Tax Passive Income Under Section 936: An Evaluation", San Juan: First Federal Savings Bank, October, 1985, mimeo. 24 pp.

United Nations, ECLA/UNEP, Caribbean Environment Programme Action Plan: Development and Environment in the Wider Caribbean Region: A Synthesis. Report of Meeting of Government Nominated Experts to Review Draft Action Plan for the Wider Caribbean Region, Caracas, 28 Jan-1 Feb, 1980

United Nations, FAO, Yearbook of Forest Products, Rome: FAO, 1984.

United Nations, FAO, Yearbook of Fishery Statistics: 1982, v. 54, Catches & Landings, V. 55, Fishery Commodities. Rome, 1955.

U.S. Army Corps of Engineers, Ponce Regional Water Resources Management Study, U.S. Army Corps of Engineers Special Study, 1977.

U.S. Army Corps of Engineers, Island Wide Water Supply for Puerto Rico. Volume I: Main Report, Volume II: Comprehensive Analysis. U.S. Army Corps of Engineers Special Study, September, 1980. 297 pp. and 112 pp. + maps, appendices and bibliogrpahy.

U.S. Department of Commerce, Economic Study of Puerto Rico, Washington, D.C.: U.S. Government Printing Office, 1979, 2v., 339+vi and 740+x pages. Referred to in this study as the Kreps Report after Juanita Kreps, then U.S. Secretary of Commerce.

U.S. Department of the Treasury, The Operation and Effect of the Possessions Corporation System of Taxation: Fifth Report, Washington, D.C.: U.S. Government Printing Office, July, 1985.

U.S. Geological Survey, Soil Conservation Service, "Soil Survey of the Arecibo Area, Northern Puerto Rico," issued March, 1982. In cooperation with the College of Arts and Sciences, UPR at Mayaguez, prepared as technical assistance to Atlantico, Coanillas and Norte soil conservation districts.

U.S. Virgin Islands, Department of Agriculture, Annual Report, 1973

U.S. Virgin Islands, Planning Office, Annual Report, various years.

Vicente Chandler, José, Conceptos, Plan y Programa para una Agricultura Moderna en Puerto Rico, San Juan: Puerto Rico Department of Agriculture, 1978. 539 pp., maps.

Background Paper No: 7

ORGANIZATIONS DEALING WITH RENEWABLE RESOURCE DEVELOPMENT AND MANAGEMENT IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS

by

Hilda Diaz-Soltero and Boris L. Oxman

1986

Prepared for

U.S. Congress, Office of Technology Assessment,
Integrated Renewable Resource Management for U.S. Insular Areas,
Washington D.C.: U.S. Government Printing Office, 1987.

ABSTRACT

Many agencies of the United States and insular governments are involved in developing and promoting technologies for conservation, management, and sustained development of renewable resources in Puerto Rico and the U.S. Virgin Islands. Local academic institutions conduct research and provide training for professionals in some related fields. International, regional, and local non-governmental agencies operate in the islands.

The efforts of many agencies and organizations are limited by statutes. Funding is inadequate and undependable. Coordination is lacking. Various aspects of a single resource area receive attention, while other issues are not considered. Local and regional non-governmental organizations are small and have difficulty obtaining resources. There is little collaboration between public agencies and private organizations. Academic programs are not available in many essential areas; research activity is limited and fragmented. Public attitudes are not supportive of conservation or sustained management.

Opportunities exist to improve and apply technologies for sustained conservation, management, and development of renewable resources in the islands for both local consumption and for export. Effective, well-coordinated management will enhance the environment and will also provide opportunities for recreation and tourism.

TABLE OF CONTENTS

Abstract

Table of Contents

List of Tables

Chapter 1 Introduction

Chapter 2 Organizations Dealing with Renewable Resources Management and Development in Puerto Rico and the U.S. Virgin Islands

Chapter 3 The Role of Organizations

Chapter 4 The Role of the Private Sector

Chapter 5 Constraints

Chapter 6 Opportunities

Chapter 7 Potential Impacts

References

Glossary

Survey Questionnaire Form

Tables (following Page 49)

List of Tables

Table 1. Organizations Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 2. International and Regional Organizations Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 3. United States Government Agencies Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 4. Federal Agency Research, Education, Regulatory and Support or Assistance Programs in the U.S. Caribbean

Table 5. Funding for Federal Programs Related to Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 6. Insular Government Agencies and Organizations Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 7. Insular Government Funding Related to Renewable Resource Programs in Puerto Rico

Table 8. Academic Institutions Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 9. Private Organizations, including Non-Profit Groups, Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 10. Tabulation of Kinds of Constraints Identified

Table 11. Tabulation of Types of Opportunities

Table 12. Organizations that did not Respond to the Survey as of 25 February 1986

Chapter 1

INTRODUCTION

The Commonwealth of Puerto Rico and the Territory of the Virgin Islands of the United States are two jurisdictions that comprise the Caribbean possessions of the United States. From the period of early European colonization and development, each has been dependent primarily upon the exploitation of renewable resources. During the past forty years, each has been transformed from essentially rural agricultural economies based upon a few major crops (sugar, coffee, tobacco) into today's complex economic mix of commerce, industry, and service activities. In the process, agricultural activity has lost its prominence in the economy, dropping to low levels of employment and productivity. New technologies have not been incorporated into the management of agriculture and natural resources. Many of the Federal and insular government agencies that were created to stimulate agricultural development during the period of rapid expansion of demand for specific crops are inflexible and incapable of responding to current challenges.

Concern with natural resources and the environment was virtually non-existent in the islands during the first two decades after the Second World War. Such concerns gathered force and momentum only after Congress enacted a series of Federal statutes that established national policy with regard to the environment at the end of the Sixties. Even though the Federal statutes were transformed into local laws and programs, insular agencies did not possess the expertise, the personnel, or the funding required for the effective sustainable development, conservation, and management of the renewable resources of the Islands.

The citizenry of the islands did not possess the same level of interest in and awareness of natural resource problems and potentials that was present in the continental United States, and which provided the impetus for national and state pollution control egislation. This situation is changing in the islands, but very slowly.

There are many Federal and insular agencies charged with different responsibility for various aspects of conservation, management, and development of renewable resources in Puerto Rico and the U.S. Virgin Islands. Some are conscious of the need to expand their horizons to accommodate new activities, but are limited by the statutes under which they were created. A few are attempting to have an impact, but are constrained by funding limitations. Technology for more effective management exists, but in many areas it is not available, or if it is available, it is beyond the financial capacity of many individuals and agencies to obtain and put into practice. Several new non-governmental organizations have been established by concerned individuals and groups, but local statutes and attitudes hamper their ability to raise funds with which to carry on their programs.

Many opportunities exist to change public attitudes; to improve the management and advisory capabilities of Federal and insular agencies; to promote interaction among public agencies, academic institutions, and non-governmental organizations; and to enable the private sector to participate more effectively in the sustainable development of renewable resources. In the context of this document, renewable resources include all forms of agriculture, air, soils and water, fisheries, forestry, wildlife, and coastal and marine resources.

The implementation of the opportunities identified in this report will improve the conservation and management of renewable resources. However, the islands have never been completely self-sufficient in terms of renewable resources, and never will be, because of their relatively small physical size and their large and growing populations.

Chapter 2

ORGANIZATIONS DEALING WITH RENEWABLE RESOURCES MANAGEMENT AND DEVELOPMENT IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS

Puerto Rico and the U.S. Virgin Islands benefit from the existence of a diverse group of renewable resource-related organizations that play various roles in the conservation and development of their natural and agricultural resources and in the implementation of renewable resource sustaining technologies in the U.S. Caribbean.

These organizations are concerned with such renewable resources as soils, air, water, plants and forests, fish and wildlife, and marine and coastal resources. Puerto Rico and the U.S. Virgin Islands are tropical islands with diverse ecosystems that are at once wonderfully unique, extremely valuable, and terribly fragile. The small physical size of the islands limits the quantity of resources available for conservation and sustained development on each island. Another important factor is the large number of people who inhabit the islands and who depend on those resources for their everyday sustenance, economic well-being, and recreational needs.

Table 1 lists the 154 organizations in or related to renewable resources in Puerto Rico and the U.S. Virgin Islands that were approached in connection with this study. A copy of the survey questionnaire is appended to the report. Each of the organizations that responded to the survey is described in greater detail in subsequent tables. They may be divided into several major categories:

- International and regional organizations: 9 approached; 8 responded. (Table 2);

- United States government agencies: 30 approached; 26 responded. (Table 3)

- Insular government agencies: 41 approached; 29 responded. (Table 6)

- Academic institutions: 24 approached; 10 responded. (Table 8)

- Non-governmental organizations, including private non-profit and for-profit groups: 50 approached; 24 responded. (Table 9)

The tables identified list, for each of the 97 organizations that responded, the following kinds of information, as collected from the survey questionnaires.

Organization name
Location
Mailing Address and telephone
Name and title of director
Year established
Primary and secondary areas of interest
Types of activities conducted or supported
Kinds of support offered
Sources of funds
Geographic area served
Clientele for each type of activity
Summary of previous year's major activities
Major role visualized for the organizations
Major constraints encountered
Opportunities anticipated for the short range
Potential impacts that might be realized

The following chapter discusses the roles and the effects of each of the several categories of organizations in the U.S. Caribbean region.

Chapter 3

THE ROLE OF ORGANIZATIONS IN ESTABLISHING SUSTAINED RENEWABLE RESOURCE DEVELOPMENT IN PUERTO RICO AND THE U.S VIRGIN ISLANDS.

There is a moderate level of institutional activity related to the sustainable development and management of renewable resources in Puerto Rico and the U.S. Virgin Islands. This Chapter reviews the roles of various types of organizations that are involved in research, building institutional capabilities and relationships, funding, and the development or transfer of technology.

International and Regional Organizations

During the last ten years, a few international organizations have begun to focus attention on natural resources issues in Puerto Rico and the U.S. Virgin Islands, but at a minimal level of activity. There are only nine organizations in this category (Refer to Tables 1 and 2). Two of them are truly international in scope and interest: the International Association of Fish and Wildlife Agencies and the International Society of Tropical Foresters. Another two, the American Association for the Advancement of Science and the Southeastern Association of Fish and Wildlife Agencies, are regional organizations that work primarily in the United States. There are five organizations with a specific interest in the Caribbean region: the Caribbean Conservation Association, the Caribbean Institute of Resources Management, the Eastern Caribbean Natural Areas Management Program, the Gulf and Caribbean Fisheries Institute of the University of Miamí, and the Island Resources Foundation.

Both islands are involved in the Man and the Biosphere Program (MAB), sponsored by the United Nations Educational, Scientific and Cultural Organization (UNESCO). The contacts to MAB are through the United States government.

International and regional organizations play a variety of roles in the conservation and development of natural resources in Puerto Rico and the U.S. Virgin Islands, with special attention to forests and to fish and wildlife. Each of the organizations has different objectives, programs and activities. All are non-governmental and non-profit. Few of the organizations offer grants; most conduct environmental education programs and technology transfer. None of them is involved in research. All of them focus on the islands or on the Caribbean region as a whole. None of the organizations operates at a site-specific level.

Membership in these organizations reflects a broad spectrum. Membership is entirely voluntary. In some cases, members are government agencies. The Puerto Rico Department of Natural Resources, for instance, is a member of the International Association of Fish and Wildlife Agencies and of the Caribbean Conservation Association. In other instances, membership is open to individuals. Such persons may be affiliated at the same time with an agency of the Federal or insular government, an academic institution, or a private organization, or they may not be affiliated with any other group. This appears to be the case of the members of the International Society of Tropical Foresters and of the American Association for the Advancement of Science. The several dividuals in Puerto Rico and the U.S. Virgin Islands who belong to the latter groups have few opportunities to meet and exchange information related to local matters. The Caribbean Conservation Association has a mixed membership that includes national representatives, non-profit regional and local organizations, and individuals, all of which are represented on the governing board of the Association.

The wide diversity of functions and goals of the international and regional agencies creates problems and inefficiencies. There appears to be a total lack of communication among the organizations, or even among members of the same organization, in some instances. The organizations do not share a coherent strategy to establish priorities, timing, or scope for their activities. Each of the organizations works on its own, with neither knowledge of nor interest in the activities of the others. Occasionally, this results in a duplication of efforts related to a specific environmental concern.

Of the nine international or regional organizations, the Caribbean Institute for Resources Management is based in Puerto Rico, the Island Resources Foundation and the Eastern Caribbean Natural Areas Management Program are located in the U.S. Virgin Islands, and the Caribbean Conservation Association is in Barbados. The remaining five are based in the United States. Thus, the geographic location of the main headquarters offices may drastically diminish the effectiveness of the their potential impact on resource management in Puerto Rico and the U.S. Virgin Islands.

Up to the present time, the international and regional organizations have had little or no impact upon the conservation, management or development of agricultural resources in Puerto Rico and the U.S. Virgin Islands. Their impact upon the conservation and management of other natural resources has been negligible. Interaction with international or regional organizations depends entirely upon the personal interest of individuals or agencies in Puerto Rico or the U.S. Virgin Islands, rather than in the other direction, which would be more appropriate and effective.

United States Government Agencies and Programs

The United States government agencies working with sustainable development and management of renewable resources maintain a modest presence in Puerto Rico and the U.S. Virgin Islands (Refer to Tables 1, 3, 4 and 5).

Six executive departments (Agriculture, Commerce, Defense, Health and Human Services, Interior, and Transportation, with a total of 22 programs), and two independent Federal agencies (Emergency Management and Environmental Protection) operate in both Puerto Rico and the U.S. Virgin Islands. The Departments of Agriculture and the Interior have five activities that relate only to Puerto Rico and another two that relate only to the U.S. Virgin Islands. Thus, in sum, there are 30 Federal programs that relate directly or indirectly to various aspects of renewable resources in the U.S. Caribbean. Details concerning the agencies and programs are set forth in Table 3. A comparison of their various roles is presented in Table 4.

The local offices of those agencies are situated in the major urban centers - San Juan in Puerto Rico and Charlotte Amalie on St. Thomas in the U.S. Virgin Islands. Their human and economic resources are quite limited, in comparison to those available to Federal agencies in the other states of the nation. Table 5 presents an analysis of Federal expenditures for grants, direct payments, and other activities related to renewable resources, insofar as it is possible to identify those programs in the available publications.

Puerto Rico and the U.S. Virgin Islands each has one elected offical to represent their interests in Congress. Puerto Rico's Resident Commissioner and the Delegate of the Virgin Islands are each provided with office space, staff and franking privileges by the House of Representatives; they participate and vote in committees of the House, but they may not vote on the floor of the House when final action is taken on legislation. This lack of political power hinders effective lobbying for programs and/or appropriations related to renewable resources affecting the insular jurisdictions. Further, a general lack of knowledge and appropriate contacts in Washington minimizes the efforts of local individuals, groups and agencies of the insular governments to provide essential information or simply to express opinions to the Congress concerning national government actions or programs in the islands.

Federal agencies play various roles. The following twelve agencies conduct research programs and projects related to renewable resources, or fund research activities conducted by local organizations, as indicated:

Department of Agriculture:
  Agricultural Research Service (Rio Piedras)
  ARS: Tropical Agriculture Research Station (Mayaguez)
  Forest Service:
    Caribbean National Forest
    Institute of Tropical Forestry
Department of Commerce:
  National Oceanic and Atmospheric Administration:
    National Ocean Service:
      Office of Ocean and Coastal Resources Management
        (grants to PR Department of Natural Resources and
        VI Department of Conservation and Cultural Affairs)
    National Sea Grant College Program
      (grants to University of Puerto Rico, Department of
      Marine Sciences also serve the USVI)

Department of the Interior:
  Fish and Wildlife Service, Caribbean Area Office
  Geological Survey:
    Geology Division
    Water Resources Division
  National Park Service:
    Virgin Islands National Park
Environmental Protection Agency
Federal Emergency Management Agency
  (Contracts to PR Department of Natural Resources and others)

Very little of the in-house research performed by these agencies is coordinated with the other Federal agencies, nor is it the result of a comprehensive research strategy that is developed in collaboration with other Federal agencies or with insular agencies. The research projects conducted by insular agencies under Federal grant programs generally respond to national priorities expressed in the legislation that established each program or in the Federal Regulations that provide the basis for awarding grants.

Federal agencies also play a modest role in educating the public with regard to renewable resources. Although education is not identified as an area of primary interest, the following six Federal agencies do conduct or assist educational programs:

Department of Agriculture:
  Cooperative Extension Service
  Soil Conservation Service

Department of Commerce:
  National Oceanic and Atmospheric Administration:
    National Ocean Service:
      Office of Ocean and Coastal Resources Management
        (grants to PR Department of Natural Resources and
        VI Department of Conservation and Cultural Affairs)
    National Sea Grant College Program
      (grants to the University of Puerto Rico Department
      of Marine Science)
Department of the Interior:
  Fish and Wildlife Service:
    Caribbean Islands National Wildlife Refuge
Environmental Protection Agency

The in-house educational programs are small, and rely primarily on written materials designed for parties interested in specific activities. There is no coherent Federal strategy to promote sound management, conservation, and development practices for renewable resources, beyond the requirements of Executive Orders 11988 and 11990. Some agencies publish materials in Spanish, but others do not. There is a tremendous need for a broadened, well-coordinated Federal approach to public awareness related to renewable resources, both to enlarge upon the information being disseminated and to reach various segments of the local population through different communications media.

Another group of Federal agencies perform regulatory missions, promoting laws, rules, regulations, and sound practices of conservation or management related to renewable resources. Included among such agencies are the following:

Department of Agriculture:
  Agriculturasl Stabilization and Conservation Service
  Animal and Plant Health Inspection Service
  Meat and Poultry Inspection Service
Department of Commerce:
  NOAA - National Marine Fisheries Service
    Caribbean Fisheries Management Council
Department of Defense:
  U.S. Army Corps of Engineers
    Jacksonville District, San Juan Area Office
Department of the Interior:
  Fish and Wildlife Service:
    Caribbean Area Office
    Law Enforcement Office
Department of Transportation:
  Coast Guard:
    Marine Safety Office
Environmental Protection Agency.

Yet Another group of Federal agencies promotes, supports, and/or implements a broad range of resource conservation or development projects. Such projects range from support for crop production to flood control works. Agencies that carry out or support such projects include:

Department of Agriculture
  Agricultural Conservation and Stabilization Service
  Cooperative Extension Service
  Farmers Home Administration
  Food and Nutrition Service
  Forest Service
  Soil Conservation Service

Department of Commerce:
  National Oceanic and Atmospheric Administration:
    National Ocean Service,
      Office of Ocean and Coastal Resource Management
    National Marine Fisheries Service:
      Caribbean Fisheries Management Council
    National Sea Grant College Program
Department of Defense:
  U.S. Army Corps of Engineers:
    Jacksonville District, San Juan Area Office
Department of the Interior:
  Fish and Wildlife Service:
    Caribbean Area Field Office
    Caribbean Islands National Wildlife Refuge
  Geologic Survey:
    Geology Division
    Water Resources Division
Envronmental Protection Agency

Projects undertaken or supported by these agencies tend to be site-specific, and respond to an urgent or important aspect of conservation or development of renewable resources. Most projects have a short duration, of one or two years. Generally, they are carried out by agency staff already assigned to duty in Puerto Rico or the U.S. Virgin Islands. Technical experts are seldom brought into the islands from the United States or other areas. While some projects are generated and promoted by the Federal agencies, many others are generated by requests from local government agencies. Few projects seem to be promoted by individuals or private organizations. Most Federal projects appear to be successful, but their results are seldom publicized, minimizing their potential impact. An important problem of some Federal agencies that implement projects is that there is little long range planning, due to an absence of a long term Federal policy base, including a reliable budget process and a shortage of planning funds, personnel or data.

To summarize, there are 30 Federal programs dealing with renewable resources in Puerto Rico and the U.S. Virgin Islands. The relatively modest role that they play in the U.S. Caribbean islands is evident when one notes the funds allocated to the various programs in proportion to the national totals, as presented in Table 5.

Insular Government Agencies

Agencies of the governments of Puerto Rico and the U.S. Virgin Islands have been involved in agricultural research, education, regulation and project implementation for several decades. Similar involvement in natural resources issues has occurred only during the last twelve years. Government environmental awareness and concern for proper renewable resource management are relatively recent.

It is most important not to be misled by the large number (41) of local government agencies involved in some aspect of renewable resources. Tables 1, 6 and 7 identify those agencies and provide specific information. In only six of those agencies do development, management and conservation of tropical renewable resources command a high priority. Most of the agencies devote a major portion of their funds and staff efforts to other kinds of activities. When the total budget for sustainable renewable resources is compared to the total insular budget, it represents only a small fraction, and it is truly extremely small and inadequate in comparison to the extraordinary level of need.

Puerto Rico

Table 6 presents information concerning the agencies within Puerto Rico's legislative and executive branches that relate to renewable resources, as well as executive branch agencies of the government of the U.S. Virgin Islands. Table 7 presents available budget data from the Governor's Consolidated Executive Budget of the Commonwealth of Puerto Rico for Fiscal Year 1985- 1986.

Puerto Rico's legislative committees play various roles related to the development and enactment of legislation affecting renewable resources. During the past five years, new legislation has been promoted by executive agencies and by non-governmental organizations. A most important role is that of approving the annual budget and the related appropriations for all government agencies and programs that are involved in agriculture or natural resources. The committees also conduct in-depth studies or evaluations of specific issues or agencies related to renewable resources. The Senate Committee is particularly active, creative, effective, and sensitive in dealing with such issues.

Two important regulatory agencies are located in the Office of the Governor of Puerto Rico: the Planning Board and the Environmental Quality Board. The Planning Board has adopted island-wide land use policies and maps which identify agricultural lands to be retained in cultivation and other natural areas to be conserved. The Planning Board also identifies floodable areas and regulates development in them in accordance with the adopted land use policies. The Board is the state single point of contact for the review of all federally assisted projects undertaken by local government agencies, municipalities, public corporations and private organizations. The Board, with inputs from other government agencies, prepares and adopts a comprehensive Four Year

Investment Program which provides guidance for the Governor and the Budget Director in assigning priorities for funding the various government programs, as well as for capital investment in physical facilities. The Board's research role with respect to renewable resources is limited, although it has promoted or participated in special studies of critical natural areas. The Board's education role is limited to the publication of periodic reports on the economy and social conditions, with relatively little emphasis on environmental or resource matters.

The Environmental Quality Board establishes public environmental policy and conducts a modest educational program. It provides some technical assistance in relation to the monitoring of pollution control programs for air, water, noise, and hazardous wastes. Its staff evaluates environmental impact statements submitted by proponents of development projects to assure that such development is environmentally compatible.

The other agencies of the insular government perform the usual wide variety of functions. Within some agencies it is possible to encounter research, education, regulation, management, and project implementation. Very few of the insular agencies play only one of those roles.

Research activities are carried on within the following agencies:

Department of Agriculture
Department of Natural Resources
Tourism Company
Government Development Bank
CODREMAR

This research covers a variety of topics, ranging from fisheries, wildlife and endangered species to tourism sites, potential new crops and agricultural pest controls. Local funding for research is very limited. There are few long range research activities.

No insular agencies have significant educational programs related to renewable resources. Very modest efforts are conducted by the following three organizations:

Environmental Quality Board
Department of Agriculture, Soil Conservation Committee
Department of Natural Resources
Aqueduct and Sewer Authority
CODREMAR

Insular agencies with regulatory responsibilities related to renewable resources include the following:

Planning Board
Environmental Quality Board
Department of Agriculture, Milk Industry Regulation Office
Department of Commerce
Department of Health, Environmental Health Secretariat
Department of Natural Resources
Regulations and Permits Administration

Insular laws and regulations relating to renewable resources cover a wide range of topics, including importation of plants, slaughterhouses, pesticides, hunting and fishing, endangered species, and water resources. When compared to other developing countries, that body of laws and regulations is very complete, but much of it is out of date and must be revised in the light of new technology and problems. The greatest problem is the lack of trained personnel and funds for enforcement of the regulations. Many of Puerto Rico's laws and regulations are modelled on similar statutes on the mainland.

Many insular agencies implement projects related to the conservation or management of renewable resources. They include:

- Department of Agriculture
  - Soil Conservation Committee
- Department of Natural Resources
  - Coastal Zone Management Program
  - Forests, Reserves, and Sanctuaries Secretariat
  - Operations Secretariat
  - Resources Planning Secretariat
- CODREMAR
- Culebra Conservation and Development Authority
- Environmental Quality Board
- Land Authority
- Land Administration
- Recreation Development Company

The following agencies are involved in the regulation or implementation of development projects related to renewable resources:

- Planning Board
- Cooperative Development Administration
- Agricultural Services Administration
- Department of Commerce

Department of Natural Resources
  Flood Control Secretariat
  Forests, Reserves, and Sanctuaries Secretariat
  Operations Secretariat
CODREMAR
Culebra Conservation and Development Authority
Land Administration
Land Authority
Aqueduct and Sewer Authority
Dairy Industry Corporation
Electric Power Authority, Irrigation Division
Milk Industry Development Fund
Rural Development Corporation
Solid Waste Management Authority
Sugar Corporation
Tourism Company

Most of these projects are short term (four years or less). They lack interagency coordination.

The general impression is that the agencies of the Government of Puerto Rico exercise major influence and have a great impact upon management, conservation, and development of the island's renewable resources. Yet there is a great need to raise the general level of awareness related to sustained development of renewable resources, and to generate a broader long range commitment of both fiscal and human resources for these efforts.

U.S. Virgin Islands

In the U.S. Virgin Islands government there are two executive agencies with primary responsibilities for renewable resources programs. They are

Department of Agriculture

Department of Conservation and Cultural Affairs (DCCA)
  Coastal Zone Management Program
  Bureau of Environmental Enforcement
  Division of Fish and Wildlife
  Division of Natural Resources Management

The DCCA units conduct some research and technical assistance, as well as management, regulatory, and law enforcement activities. The Coastal Zone Management Program and the Department of Education also carry on limited education efforts related to natural resources. The impact of the U.S. Virgin Islands government agencies on the conservation, development, and management of renewable resources is relatively small.

Academic Institutions

Academic institutions play multiple roles, including research, technology transfer, and project development and implementation, but their primary role is education of students in some renewable resource related professions. Public awareness programs are relatively less important for them.

There are two important multi-campus educational institutions within the U.S. Caribbean region that are involved in major renewable resources programs: the University of Puerto Rico (UPR) and the College of the Virgin Islands (CVI). Fairleigh Dickinson University (based in New Jersey) maintains the West Indies Laboratory in the Virgin Islands. Data for the three institutions and their several subsidiaries are presented in Tables 1 and 8.

Puerto Rico

UPR has several campuses and many academic subunits or programs, many of which are devoted to a particular resource area, either at the undergraduate or graduate level, or both. The Mayaguez Campus houses the Land Grant College in which the work on agriculture is conducted. These activities include the College of Agricultural Science, the Agricultural Experiment Station, and the Agricultural Extension Service. The relatively new regional college in the mountain town of Utuado also concentrates on agriculture.

Renewable resources matters also are studied in such other UPR units as the Botanical Garden, the Center for Energy and Environmental Research, the Departments of Biology at the various campuses, and the Department of Marine Sciences at Mayaguez (which also conducts the Sea Grant College Program). The Humacao University College of UPR also conducts an educational concentration in marine biology. Of all these activities, the College of Agricultural Sciences, the Department of Biology, the Department of Marine Science, the Humacao University College and the Regional College at Utuado have student education as their primary role.

Although there are several private universities in Puerto Rico, only Interamerican University maintains an interest in marine biology and related ecological matters at its small original campus in San German, but relatively few faculty or students are involved.

U.S. Virgin Islands

Courses in agriculture are included in the curriculum of the CVI, but it does not have a degree program in that area. CVI does maintain the Agricultural Experiment Station and the Cooperative Extension Service for the Virgin Islands. It also has a number of sub-units related to renewable resources. The Caribbean Research Institute operates a number of specialty areas, including the Water Resources Research Center. The Marine Advisory Service is funded through the Sea Grant College Program at UPR. The Virgin Islands Ecological Research Station on St John works in the Virgin Islands National Park.

Summary

Academic institutions train their students in agronomy, biology, and marine sciences. The faculty and economic resources devoted to these subjects is relatively small. Specialized graduate or doctoral programs related to other renewable resources are not available. There is a need for new courses or programs on tropical forestry, agroforestry, wildlife management, water resources conservation and management, modern agricultural techniques, marketing of agricultural and other resource products, and similar matters. However, it may not be feasible in these relatively small islands to attract specialized faculty and sustain a sufficient number of students to justify the full range of courses related to renewable resources management and development.

Non-governmental Organizations

During the past fifteen years private citizens have been voicing increasing concern over agricultural and environmental issues. One of the results has been the establishment of many diverse non-profit non-governmental organizations (NGOs). Each NGO has a particular interest in some aspect of renewable resources. Some are concerned with a specific resource, such as agriculture, animal production, animal protection, birds, camping, environmental education, fishing, habitat protection, horticulture, soil conservation, and speleology. Others are oriented toward commerce, cooperatives, manufacturing and other activities based upon renewable resources, in part related to the need to diversify farm production and to develop new credit sources.

Puerto Rico

In Puerto Rico, 44 NGOs have been identified, of which 27 are involved with natural resources, 12 are related to agriculture, and the remaining five are involved in generally related areas. There are six NGOs in the U.S. Virgin Islands, involved with natural resources. All of these groups are local organizations whose sphere of action or influence is limited to one or the other of the two jurisdictions. Refer to Tables 1 and 9 for details about these groups. It is also worthy of note that the international and regional organizations discussed previously are all NGOs. However, since their spheres of action are much larger and their primary interests are not focused on Puerto Rico or the U.S. Virgin Islands, they have been treated as a separate group.

Most of the local NGOs are very small, with fewer than 75 members. The members of the NGOs interested in natural resources tend to be amateurs, while the members of the groups concerned with agriculture tend to be agronomists or practicing farmers. Very few of the local NGOs have paid professional staff and appropriate budgets. The level of activity and their effectiveness in dealing with renewable resource issues depend in large measure upon the particular qualifications of the president and members of the board of directors during a given period. Their tenure in office is usually one or two years.

The NGOs concerned with natural resources have been involved in several kinds of activity, including resource inventories (i.e., the Borinquen Audubon Society and the PR Ornithological Society in bird censuses), financing of research activity (i.e., PR Manufacturers Association in financing for groundwater research), habitat acquisition and protection (i.e., Puerto Rico Conservation Trust), field trips to natural and cultural sites (i.e., Natural History Society and Fondo de Mejoramiento), the enjoyment or exploration of specific natural resources (i.e., Borinquen Audubon Society, PR Ornithological Society, PR Speleological Society, Fishermens' Associations, Horticultural Society, Garden Club, Campers' Association), project implementation (i.e., Conservation Trust, Garden Club, and Humane Society), environmental education (Conservation Trust, Fondo de Mejoramiento, and Natural History Society), and scholarship aid (i.e., Garden Club and Natural History Society).

The Fishermens' Federation ais the only NGO related to natural resources whose members not only enjoy their activity as a hobby or sport, but depend on it for their livelihood. In that NGO, many members are artesanal fishermen who belong to small groups (10 to 20 members) which are affiliated with the Federation. Freshwater sport fishermen are organized into two large NGOs, but hunters are represented by many small local organizations.

Puerto Rico's NGOs oriented toward agriculture have been involved in such activities as financing for land acquisition (i.e., Federal Land Bank and Farm Credit Bank of Baltimore), financing of agricultural projects (i.e., Puerto Rico Production Credit Association), development of projects (i.e., Agricultural Development Federation, Agro-commercial Cooperative, Tropic Venture), limited research oriented toward a specific project (i.e., Agricultural Development Federation), and modest efforts at providing technical assistance (i.e., Agricultural Development Federation, Agro-Commercial Cooperative, and Puerto Rico Farm Bureau, Tropic Venture).

U.S. Virgin Islands

Although there is less agricultural activity in the USVI, there appears to be a greater interest in promoting cooperation among the public and private activities. In addition, there has been a greater interest in developing tourist attractions that relate closely to the renewable resources of the islands.

Summary

Although none of the NGOs has regulatory responsibilities, most are aware of laws, rules and regulations promoting the conservation and sustainable development of renewable resources. NGOs not only advise their members about the need to comply with such regulations, but they inform the regulatory agencies, and often the news media, about major violations. Occasionally, there is collaboration between Federal and insular government agencies and NGOs for the promotion of a particular piece of legislation, dissemination of information on a specific issue, or the implementation of a specific program or project. Also, when there are particularly complex renewable resource issues about which the Federal or insular government agencies are wary of action because of political constraints, NGOs have played a key role in formulating the need and in demanding governmental action. This may be one of the most important roles for NGOs.

Except for ECNAMP, there is little or no formal interaction among international and regional organizations, academic institutions, and local NGOs, although some individuals may hold membership in several groups at once.

Chapter 4

THE ROLE OF THE PRIVATE SECTOR

In Puerto Rico and the U.S. Virgin Islands, the private sector's role in the conservation and management of renewable resources is negligible. There is only one instance in which private enterprises are funding part of a public agency research activity. That project is the north coast groundwater study being undertaken by the U.S. Geological Survey and the Department of Natural Resources, for which the Puerto Rico Manufacturers Association has agreed to pay fifty per cent of the cost. Conservation and management of renewable resources is primarily the responsibility of insular agencies and secondarily, of the Federal agencies. The role of international, local, and regional NGOs is very modest, to the present.

The private sector is involved chiefly in renewable resource development projects in Puerto Rico and the U.S. Virgin Islands. But most such projects are conducted for short-term exploitation of the resources, rather than being planned or implemented for long term sustained development. Industria Avicola and To-Rico are typical examples of such companies.

Forestry resources in Puerto Rico are minimally exploited. Fewer than ten individuals with portable sawmills cut timber for fence posts, lumber, or wood for artesenal furniture makers. They have a negligible impact on the forestry resource. Their primary activity is thinning pine or mahogany plantations or cutting secondary growth forests. The Department of Natural Resources sponsors programs for reforestation, timber management and wood utilization by small private land owners.

Tropic Venture is a relatively new company that is trying to promote reforestation related to selected species that are used for artesanal woodworking and other purposes.

The private sector makes both consumptive (hunting and fishing) and non-consumptive (bird-watching, camping, hiking, nature photography, etc) use of wildlife resources. There is evidence of a major decline in wildlife resources, but this is due more to habitat destruction than to hunting pressure. There are approximately 3,900 licensed hunters in Puerto Rico. Hunted species include pigs, goats, waterfowl (ducks), doves, and pigeons. Federal and local wildlife laws and regulations establish hunting seasons and bag limits. There is a great need for hunter education; none exists at present.

Fishing is conducted only by private sector groups. There are about 2,700 artesenal fishermen with commercial fishing licenses in Puerto Rico. Generally, they are poorly educated, low-income persons who use small boats (15 to 25 feet in length) and fish on the narrow insular shelf. Most of the fishermen have other jobs, since it is impossible to live on the earnings from small-scale fishining alone. The fishermen are organized in small groups or associations, of which there are about 80 at the present time. These local associations comprise the membership of the Fishermens' Federation, a NGO.

There are also many sport fishermen in Puerto Rico and the U.S. Virgin Islands. Some of them enjoy recreational fishing in ocean waters, but there is a large well-organized group that uses Puerto Rico's fresh-water lakes and reservoirs. The sport fishermen tend to be middle-class individuals with regular employment, and their fishing activity usually occurs on weekends. There are five large private yacht clubs in Puerto Rico (located at Fajardo, Mayaguez, Ponce, and two in the San Juan metropolitan area), and several marinas.

Sailing, scuba diving, snorkeling, surfing, swimming, and other water sports are other uses of marine resources in Puerto Rico and the U.S. Virgin Islands. All of these activities, as well as related economic endeavors, are in the hands of the private sector. Although beaches in Puerto Rico are considered to be in the public domain, and accessible to all residents, there are only a few beach facilities that have been developed by the Recreation Development Company, a public corporation.

The private sector role is more intense in the agricultural sector. Most agricultural activity is in the hands of farmers who own or rent their farm land. Although government agencies may rent land or provide credit for agricultural development, it is the private individuals or companies that implement such projects. There is important agricultural activity in the following products: sugar, coffee, rice, vegetables, and such fruits as avocados, citrus and mangos. In the area of animal husbandry, there are farms that raise beef, hogs, poultry, and dairy products. Ornamental plants provide major exports. The financing of agricultural projects is provided by Federal and insular credit agencies, NGOs and private banks. Agricultural development is hampered by the small size of farms, aging farm population (the average age of farmers in 1982 was 56 years), lack of capital, high labor costs, poor marketing arrangements, and an apparent reluctance to make use of modern, more effective technology

Chapter 5

CONSTRAINTS

There are major constraints to the effective involvement of the international, regional, Federal and local government agencies, and private organizations in the sustainable development and management of renewable resources in the U.S. Caribbean islands. This chapter will review and discuss the constraints that apply to the various roles played by those organizations: research, education, regulation, and implementation of projects. Some of the constraints may apply to a single activity, but not to others. Table 10 lists the major kinds of constraints that were mentioned in the responses by various organizations.

Lack of Economic Resources

The lack of sufficient economic resources is a very serious constraint for sustainable development of renewable resources. It particularly affects research, public education, and regulatory efforts, although it also has an important impact on academic institutions and the implementation of resource development and conservation projects.

The lack of funds for research results in short term, discontinuous, uncoordinated research projects. It also creates enormous difficulties in the recruitment and retention in the islands of qualified, properly trained research scientists and technicians. At present, most of the research funds originate in Federal programs, such as the Sea Grant College Program (to the Department of Marine Sciences at the UPR in Mayaguez), Pittman-Robertson funds for wildlife (to the Department of Natural Resources), Dingell-Johnson funds for fisheries (to the Department of Natural Resources), agricultural research funds (to the Agricultural Research Service and the Agricultural Experiment Stations), and the forestry funds (to the Institute of Tropical Forestry). Table 5 indicates the levels of Federal funds expended in Puerto Rico and the U.S. Virgin Islands. Research programs are included within some of the grant activities, but they are not always identified as such. Funding for renewable resources research is virtually non-existant in the budgets of the insular governments. Only the UPR Agricultural Experiment Station, the Botanical Garden, and the Center for Energy and Environmental Research are receiving small amounts for research from the budget of the Commonwealth of Puerto Rico. The lack of funds for research has hampered the establishment of an urgently needed center for data collection, basic inventories and research on tropical renewable resources in Puerto Rico and the U.S. Virgin Islands. This information would provide the basis for all other efforts to properly manage, conserve, or develop the renewable resources of the islands.

The lack of funds for renewable resources programs also has an enormous adverse impact on the academic institutions of the region. It is difficult to recruit and keep resource specialists on the faculty. As a result, programs related to natural resources are virtually non-existant; related programs for agriculture are in place, but are incomplete and inadequate. Another result is that very few students are attracted and trained in resource-related professions. Many of those who do graduate cannot find meaningful employment in insular or Federal government agencies or in the private sector. Therefore, they end up changing careers to other fields.

Public awareness programs related to agriculture and natural resources also suffer because of the lack of funds. The only modest efforts are being conducted by the UPR Agricultural Extension Service and the similar activity of the Sea Grant College Program being implemented by the Department of Marine Science for both Puerto Rico and the U.S. Virgin Islands. Such public awareness programs are desperately needed to explain to citizens and public officials the extraordinary importance of sustainable development strategies and essential conservation activities for the islands' scarce renewable resources. The generation of responsible public awareness and commitment to renewable resources is one of the most important elements of a long range strategy for their conservation and sustainable development.

Regulatory activities are also hampered by the lack of funds. The number of enforcement officials is insufficient for the amount of activity to be monitored, and most of them lack appropriate training. Local government pay scales are low, creating serious recruitment and retention problems for the agencies charged with enforcement of laws and regulations. Serious budget limitations also inhibit the purchase, operation and maintenance of vehicles, boats, and aircraft required to conduct the monitoring and surveillance activities. It is almost impossible to provide the specialized training required to enable attorneys to process environmental cases before the courts or to draft sorely needed amendments or new legislation that is appropriate for the islands.

The implementation of renewable resources projects is also severely hampered by financial constraints. Most projects must be short term, of limited scope, and must address simple situations. They must be carried out with a minimum of human resources, equipment, and materials. Frequently, the interest, time and funds are lacking for publication and dissemination of project results. This affects educational programs and results in a lack of interaction with other persons or organizations interested in similar matters. Thus, a lack of knowledge of other work may lead to a potential replication of effort. Sometimes, projects are left unfinished, but more generally they are conducted without appropriate follow-up because there is no funding beyond the initial activity. It is essential that organizations at all levels recognize and accept the fact that many renewable resource projects must be long term. It is almost impossible to obtain funding for renewable resource projects for more than two years. While economic support for renewable resources projects is scarce, similar support fpr sonservation, restoration, and management projects is almost non-existant. Organizations that sponsor renewable resources must become more active in identifying new sources and increasing the funding available for such programs. They must take a long, hard look at the existing financial resources, establish clear priorities, and design new, creative, and innovative approaches to get the most out of present funds. Organizations must also establish stronger and closer collaboration and coordination with one another to avoid duplication of effort and to increase efficiency and effectiveness.

Lack of Trained Personnel

There is a very serious lack of trained personnel in many of the areas related to sustainable renewable resource development, such as: agronomy, ecology, forestry, hydrology, soil sciences, veterinary medicine, wildlife management, and zoology. Training in many of these specialties is not available in the local academic institutions, forcing students to travel outside the region for such training. Few island residents can afford to spend $10,000 to $20,000 per year for four years, and those who can afford to study in the mainland states are often enticed to remain there because of the availability of better jobs, with security, opportunities for further training and career

Chapter 7

POTENTIAL IMPACTS

The small scale of the islands and the demand for land for urban development, industry, tourism, and other uses imposes certain limits on the potential area that can be dedicated to conservation, management, or sustainable development of renewable resources. The islands were never self-sufficient in terms of food and other essential resources. In view of the constraints noted, and the growing population, self-sufficiency will be limited in the future to those resources for which there is a relatively low level of local demand and/or which have a level of economic return that is sufficiently high to enable them to resist competetion from other activities.

However, the implementation of the opportunities identified in the previous chapter will result in many benefits for the islands' renewable resources, including the following:

- a comprehensive approach to public policy relating to renewable resources, including a long-term commitment of political support;
- a coherent body of statutes and complementary regulations;
- a comprehensive approach to resource planning, involving the continuous close collaboration of public agencies with academic institutions and non-governmental organizations;
- an effective program of interagency coordination, accepted as a standard practice at all levels of government;

- a set of clear, specific, non-conflictive goals and objectives related to the management, conservation, and development of renewable resources;
- a rational long term strategy for achieving sustainable development and management of renewable resources;
- an effective program of enforcement, with public acceptance and support;
- an educated, environmentally sensitive citizenry, including government officials and political leaders;
- a continuing, well rounded academic program to prepare and sustain a cadre of well trained, dedicated specialists in renewable resources;
- an array of credit mechanisms to stimulate new entrepreneurial ventures related to renewable resources;
- a vast increase in the number of successful private sector projects involved in sustainable renewable resources;
- an improvement of the insular economies, including additional jobs based upon the production of renewable resources for local consumption, manufacturing, and export;
- a major enhancement of the quality of life, including public health, education and recreation; and, finally,
- a continuous improvement in environmental quality, including the protection of critical habitats, preservation of unique ecosystems, and maintenance of the diversity of tropical island species.

REFERENCES

Commonwealth of Puerto Rico, Office of the Governor, Office of Budget and Management: Consolidated Budget of the Commonwealth of Puerto Rico for Fiscal Year 1985-1986. San Juan, Puerto Rico: 2 vol., March 1985.

U.S. Congress, Office of Technology Assessment: Technologies to Sustain Tropical Forest Resources. Washington, D.C., March 1984.

U.S. Department of Commerce, Bureau of the Census: Federal Expenditures by State, Fiscal Years 1982, 1983, 1984. Washington, D.C., 1983, 1984, 1985.

U.S. Department of Commerce, Bureau of the Census: Census of Agriculture, 1982. Washington, D.C. 1984

GLOSSARY

AFICA	Medical and Environmental Pollution Control Facilities Financing Authority
CEER	Center for Energy and Environmental Research
CODREMAR	Corporation for the Development of Marine, Lacustrine, and Fluvial Resources
CVI	College of the Virgin Islands
DCCA	Department of Conservation and Cultural Affairs
DNR	Department of Natural Resources
FS	Forest Service
FWS	Fish and Wildlife Service
INDULAC	Dairy Industry Corporation
MAB	Man and the Biosphere Program
NGO	Non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
PR	Puerto Rico (Commonwealth of Puerto Rico)
UPR	University of Puerto Rico
US	United States of America
VI	Virgin Islands (Territory of the U.S. Virgin Islands)

List of Tables

Table 1 Organizations Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 2 International and Regional Organizations Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 3 United States Government Agencies Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 4 Federal Agency Research, Education, Regulatory and Support or Assistance Programs in the U.S. Caribbean

Table 5 Funding for Federal Programs Related to Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 6 Insular Government Agencies and Organizations Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 7 Insular Government Funding Related to Renewable Resource Programs in Puerto Rico

Table 8 Academic Institutions Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 9 Private Organizations, including Non-profit Groups, Involved with Renewable Resources in Puerto Rico and the U.S. Virgin Islands

Table 10 Tabulation of Kinds of Constraints Identified

Table 11 Tabulation of Types of Opportunities

Table 12 List of Agencies and Organizations that Failed to Respond to Survey Questionnaires or whose Questionnaire was Returned as Not Deliverable, as of 30 April 1986

Table 1

RENEWABLE RESOURCES RELATED ORGANIZATIONS IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS

INTERNATIONAL AND REGIONAL ORGANIZATIONS

International Organizations

- International Association of Fish and Wildlife Agencies
- International Society of Tropical Foresters

Regional Organizations - United States

- American Association for the Advancement of Science - Caribbean Division
- Southeastern Association of Fish and Wildlife Agencies

Regional Organizations - Caribbean

- Caribbean Conservation Association
- Caribbean Institute for Resources Management
- Eastern Caribbean Natural Areas Management Program
- Gulf and Caribbean Fisheries Institute, University of Miami
- Island Resources Foundation

UNITED STATES FEDERAL AGENCIES AND ORGANIZATIONS

Operating in Both Puerto Rico and the U.S. Virgin Islands

- U.S. Department of Agriculture
  - Agricultural Research Service
    - Tropical Agriculture Research Station
  - Agricultural Stabilization and Conservation Service
  - Animal and Plant Health Inspection Service
    - Plant Protection and Quarantine Program
    - Veterinary Service
  - Cooperative Extension Service
  - Cooperative State Research Service
  - Food and Nutrition Service
  - Forest Service
    - Institute of Tropical Forestry
  - Meat and Poultry Inspection Service
  - Soil Conservation Service

- U.S. Department of Commerce
  - Economic Development Administration
  - National Oceanic and Atmospheric Administration
    - National Marine Fisheries Service
      - Caribbean Fisheries Management Council

Table 1. List of Agencies (continued) Page 2

- National Ocean Service
  - Coastal Zone Management Program
- National Sea Grant College Program
- National Weather Service

- U.S. Department of Defense
  - Department of the Army
    - Corps of Engineers - Jacksonville District

- U.S. Department of Health and Human Services
  - Food and Drug Administration

- U.S. Department of the Interior
  - Fish and Wildlife Service
    - Caribbean Area Field Office
    - Caribbean Islands National Wildlife Refuge
    - Law Enforcement Office
  - Geological Survey
    - Geology Division
    - Water Resources Division

- U.S. Department of Transportation
  - Coast Guard

- U.S. Environmental Protection Agency

- Federal Emergency Management Agency

Operating only in Puerto Rico

- U.S. Department of Agriculture
  - Agricultural Marketing Service
  - Agricultural Research Service
  - Farmers Home Administration
  - Forest Service
    - Caribbean National Forest

- U.S. Department of the Interior
  - National Park Service
    - San Juan National Historic Site

Operating only the U.S. Virgin Islands

- U.S. Department of the Interior

  - National Park Service
    - Virgin Islands National Park
    - Buck Islands Reef National Monument
    - Christiansted National Historic Site

Table 1. List of Agencies (continued) Page 3

PUERTO RICO GOVERNMENT AGENCIES AND ORGANIZATIONS

LEGISLATIVE ASSEMBLY

- Senate Committee on Agriculture and Natural Resources
- House of Representatives Committee on Agriculture
- House of Representatives Committee on Natural Resources and Environmental Quality

OFFICE OF THE GOVERNOR

- Environmental Quality Board
- Planning Board

EXECUTIVE AGENCIES

- Cooperative Development Administration

- Department of Agriculture
  - Central Office
  - Agricultural Development Administration
  - Agricultural Services Administration
  - Milk Industry Regulation Office
  - Soil Conservation Committee for Puerto Rico
  - Sugar Board of Puerto Rico

- Department of Health
  - Environmental Health Secretariat

- Department of Natural Resources

  - Central Office, including
    - Flood Control Secretariat
    - Forests, Reserves and Sanctuaries Secretariat
    - Natural Resources Ranger Corps
    - Operations Secretariat
    - Research Secretariat
    - Resources Planning Secretariat
  - Coastal Zone Management Unit

- Land Administration
- Regulations and Permits Administration (ARPE)

PUBLIC CORPORATIONS

- Agricultural Credit Corporation
- Aqueducts and Sewers Authority
- Cooperative Development Company

Table 1. List of Agencies (continued) Page 4

- Corporation for the Development of the Marine, Lacustrine and Fluvial Resources of Puerto Rico (CODREMAR)
- Culebra Conservation and Development Authority
- Dairy Industry Corporation (INDULAC)
- Electric Power Authority
  - Irrigation Division
- Farm Credit Corporation
- Government Development Bank for Puerto Rico
  - Medical and Environmental Pollution Control Facilities Financing Authority (AFICA)
  - Puerto Rico Development Fund
- Land Authority
- Milk Industry Development Fund
- Recreation Development Company
  - Zoological Garden (Mayaguez)
- Rural Development Corporation
- Solid Waste Management Authority
- Sugar Corporation of Puerto Rico
- Tourism Company

U.S. VIRGIN ISLANDS GOVERNMENT AGENCIES

EXECUTIVE AGENCIES

- Department of Agriculture
- Department of Conservation and Cultural Affairs
  - Central Office
  - Bureau of Environmental Enforcement
  - Coastal Zone Management Program
  - Bureau of Fish and Wildlife
  - Division of Natural Resources Management
- Department of Education
  - Environmental Education Program

ACADEMIC INSTITUTIONS

Puerto Rico

- University of Puerto Rico
  - Agricultural Experiment Station (Rio Piedras)
  - Agricultural Extension Service (Mayaguez)
  - Botanical Garden (Rio Piedras)
  - Center for Energy and Environmental Research (Rio Piedras)
  - College of Agricultural Sciences (Mayagüez)
  - Department of Marine Sciences/Sea Grant Program (Mayaguez)
  - Department of Biology (Rio Piedras Campus)
  - Department of Biology (Mayaguez Campus)
  - Humacao University College
  - Utuado Regional College
- Interamerican University

Table 1. List of Agencies (continued) Page 5

Virgin Islands

- College of the Virgin Islands
  - Central Office (St. Thomas)
  - Campus Office (St. Croix)
  - Agricultural Experiment Station (St. Croix)
  - Caribbean Research Institute (St. Thomas, St. Croix)
    - Environmental Science Center (St. Thomas)
    - Water Resources Research Institute (St. Croix)
- Cooperative Extension Service (St. Croix)
  - Division of Science and Mathematics (St Croix, St Thomas)
  - Marine Advisory Service (St. Thomas)
  - Marine Biology Center (St. Thomas)
  - VI Ecological Research Station (St. John)

- Fairleigh Dickinson University
  - West Indies Laboratory (St. Thomas)
    - National Undersea Research Center (St. Thomas)

NON-GOVERNMENTAL ORGANIZATIONS

Puerto Rico - Related to Agriculture

- Agricultural Cooperative Society
- Agricultural Development Federation of PR
- Agro-commercial Cooperative of PR
- Agronomists Association of PR
- Dairy Industry Development Fund
- Farm Credit Bank of Baltimore
- Federal Land Bank Association of San Juan
- 4-H Club
- Future Farmers of America
- Industrias Avicolas
- PR Farm Bureau
- PR Green Thumb
- PR Production Credit Association
- To-Rico

Puerto Rico - Related to Natural Resources

- Audubon Borinquen Society
- Campers Association
- Conservation Trust of PR
- Eastern Fishermen's Congress
- Fishermens Federation
- Fishermen's Federation of the East
- Fondo de Mejoramiento

Table 1. List of Agencies (continued) Page 6

Horticultural Society of PR
Humane Society of PR
Hunters Association of Ponce
Hunters Association of San Juan
Hunter's Federation
Hunter's Club of Arecibo
Hunter's Club of Gurabo
Hunter's Club of Juana Diaz
Hunter's Club of Palmer
Institute of Ecotechnics
Lake and River Fishermens Association
Natural History Society of PR
PR Association of Soil and Water Conservation Districts
PR Speleological Society
PR Ornithological Society
The Garden Club of PR
Tropic Venture
Wildlife Association

Puerto Rico - General

PR Chamber of Commerce
PR Community Foundation
PR Cooperative League
PR Manufacturers Association
PR Products Association

U.S. Virgin Islands

Coral World
Dyck Marine Science Center
St. George's Village Botanical Gardens
VI Conservation District
VI Conservation Society
VI Resource Management Cooperative

Table 2. INTERNATIONAL ORGANIZATIONS INVOLVED WITH RENEWABLE RESOURCES IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS

Organization Name	Location (Street/City)
American Association for the Advancement of Science - Caribbean Division (NAAS)	UPR, Rio Piedras
Caribbean Conservation Association (CCA)	Savannah Lodge, Barbados
Caribbean Institute for Resource Management (CIRM)	UPR Medical Ctr Rio Piedras
Eastern Caribbean Natural Areas Management Program (ECNAMP)	c/o West Indies Lab. St. Croix, USVI
Gulf and Caribbean Fisheries Institute, U. of Miami	Coral Gables, Fla
International Association of Fish and Wildlife Agencies (IAFWA)	1412 16th St. Washington, D.C.
International Society of Tropical Foresters (ISTF)	5400 Grovenor Lane,
Island Resources Foundation (IRF)	Estate Nazareth St. Thomas, USVI Also office in Washington, DC

Table 2 (continued) Part A

Mail Address/City/State/ZIP Code	Area Code/ Telephone
GPO Box 3682, San Juan, PR 00936	809 767.0350
Savannah Lodge, The Garrison, St Michaels, Barbados	809 426.5373
GPO Box 3682, San Juan, PR 00936	809 767.0350
Teague Bay, Christiansted St Croix, USVI 00820	809 773.9854
4600 Rickenbacker Causeway Miami, FL 33149	305 361.4190
1412 16th St. Washington, DC 20036	202 232.1652
5400 Grovenor La, Bethesda, Md, 20814	None given
PO Box 33, Red Hook, St. Thomas, USVI 00802	809 775.6225
1718 P St, NW, Washington, DC 20036	202 265.9712

Table 2 (continued) Part B

Director/s Name and Title	Year Established	Primary Area of Interest
Dr. Juan A. Bonnet, Jr. President	1984	Science and technology
Miss Jill Sheppard Executive Director	1967	Conservation/development of regional natural and cultural resources
Dr. Juan A. Bonnet, Jr. Chairman	1982	Facilitate training and research, develop information base
Allen D. Putney, Principal Investigator	1978	Conservation of natural resources and protected areas
Dr. Frank Williams Executive Secretary	1948	Research on regional fisheries
Jack H Berryman Executive Vice Pres.	1902	Conservation of fish and wildlife resources in the Western Hemisphere
Warren T. Doolittle President	1979	Promote knowledge and management of tropical forests
Edward L Towle President	1971	Planning, development and management of island environments

Table 2 (continued) Part C

Secondary Area of Interest	Types of Activity
None stated	Professional group
None stated	Research, technical assistance, projects
Provide technical assistance pool for the region	Research, technical assistance, projects
None stated	Research, technical assistance, projects
Fisheries technology	Research, technical assistance, projects
Represent members before Congress, executive agencies and other groups	Agency operations, technical assistance
None stated	Technical assistance
None stated	Research, technical assistance, projects

Table 2 (continued) Part D

Kinds of Support Offered	Fund Sources	Area Served
In-kind services, conferences	Membership dues	Caribbean region
Grants, in-kind services, information	Memberships, govt and private contributions	Caribbean region
In-kind services	Govt and private contrib, contracts	Caribbean region
In-kind services	Grants for specifc projects	Caribbean region
In-kind services	Membership fees, contracts	Caribbean region
In-kind services, materials	Membership fees	Western hemisphere
Materials	Membership fees	World-wide
In-house operations	Contributions,contracts endowment income	Caribbean islands Pacific islands

Table 2 (continued) Part E

Research Clients	Tech Assist Clients	Project Clients
Individuals	None	None
Non-profit org, public agencies, educ inst	Non-profit org, public agencies, educ inst	NPOs, public ag, educ inst
Non-profit org, companies, ed inst, public agencies	Non-profit org, companies, ed inst, public agencies	None
Non-profit organizations, ed inst, public agencies	Non-profit organizations, ed inst, public agencies	NPOs, ed inst, public agencies
None stated	None stated	None stated
None	Non profit org, public agencies	None
Individuals, educ inst, public agencies	Individuals, educational inst	NPOs,companies, educ inst,pubag
Individuals, NPOs, companies, pub agencies	Non-profit org, public agencies	Individuals, NPOs, public ag

Table 2 (continued) Part F

Summary of Past Year's Program
Organized and elected officers, held first regional conference
Support for public resource planning and management programs, conferences,assistance to interested non-profit groups
Training for 45 foresters,; planning 1986 workshop on land-based sources of marine pollutants in the Caribbean
Conferences, training programs in St Lucia; research and development projects in British and US Virgin Islands, Dominica
Conferences with published proceedings, research support workshops
Liaison to Congress, cooperation with other conservation groups, newsletter, conference proceedings, action alerts
Meetings coincide with other forestry groups
Contract research and assistance related to marine environment, coastal zone, fisheries, economic development, pollution control

Table 2 (continued) Part G

Major Role	Major Constraints
No direct role; indirectly through members	None
Assist in planning and managing natural and cultural resources of the region	Funding limitations
Technical and economic assessment ofnatural resources	Funding limitations; lack of clearly defined institutional base
Assist govt and regional NGOs in resource management	Lack of technical ability, training opportunities, coordination
Promote knowledge of available fish species and regional markets	Lack of public agency support
Promote improved fish and wildlife management in western hemisphere	Lack of public interest and support for wildlife resources
Promote professional knowledge and improved practices	Funding limitations, all-volunteer staff
Promote understanding and wise use of island resources	Funding limitation

Table 2 (continued) Part H

Major Opportunities	Potential Impacts
Expand membership	Expand opportunity for interpersonal contacts; diffusion of information
Increased financial support	More projects; improved quality of regional life and economy
Cooperate with companies & govt agencies, develop academic research linkages	Promote technology transfer, improve technical and human resource bases
Cooperation with region universities; promote small-scale projects	Improved training capacity; promote development links to conservation
Additional resources from foundations and public agencies	Greater involvement with regional advisory service and extension
Additional staff and expanded effort	Improved coverage of issues
Increased financial support	Workshops in developing countries that require professional guidance
Computer system for library and graphics capability	Improve technical aid capability for developing countries, other clients

Table 3. UNITED STATES GOVERNMENT AGENCIES INVOLVED WITH RENEWABLE RESOURCES IN PUERTO RICO AND THE U. S. VIRGIN ISLANDS

Agency and Program Activity	Location
DEPARTMENT OF AGRICULTURE	
Agricultural Research Service (ARS)	Experimental Station, Rio Piedras, PR
ARS Tropical Agriculture Research Station	University of PR, Mayaguez, PR
Agricultural Stabilization & Conservation Service	602 Federal Building Hato Rey, PR
Animal and Plant Health Inspection Service	
Plant Protection and Quarantine Program	206 Federal Bldg, Hato Rey, PR
Veterinary Services	Hipodromo Av 603, Santurce, PR
Farmers Home Administration	623 Federal Bldg, Hato Rey, PR
Food and Nutrition Service, Caribbean Area Office	220 Federal Building, Hato Rey, PR
Forest Service, Caribbean National Forest	Experimental Station, Rio Piedras, PR
FS Institute of Tropical Forestry	Experimental Station, Rio Piedras, PR
Meat and Poultry Inspection Service	206 Federal Building, Hato Rey, PR
Soil Conservation Service	639 Federal Building Hato Rey, PR
DEPARTMENT OF COMMERCE	
National Oceanic and Atmospheric Administration	
National Ocean Service - Office of Ocean and Coastal Resources Management	Washington,DC
National Marine Fisheries Service	
Caribbean Fishery Management Council	1108 Banco de Ponce Bldg, Hato Rey, PR
National Weather Service	Luis Munoz Marin Intl Airport, Isla Verde

Table 3 (continued) Part A

Mail Address	Area Code/ Telephone
Experimental Station, Rio Piedras, PR 00928	809 753.4007
PO Box 70, Mayaguez, PR 00708	809 834.2435
PO Box 11188, Santurce, PR 00910	809 753.4455
Rm 206, Fed Bldg, Hato Rey, PR 00918	809 753.4363
GPO Box 71355, San Juan, PR 00936	809 753.4932
GPO Box 6106, San Juan, PR 00936	809 753.4481
Rm 220, Federal Bldg, Hato Rey, PR 00918	809 753.4586
PO Box 21390, Rio Piedras, PR 00928	809 763.3939
PO Box 21390, Rio Piedras, PR 00928	809 753.4335
Rm 206, Federal Bldg, Hato Rey, PR 00918	809 753.4605
GPO Box 4868, San Juan, PR 00936	809 753.4206
Washington, DC 20235	301 443.8204
PO Box 1001, Hato Rey, PR 00919	809 753.4926
LMM Intl Airport, Santurce, PR 00913	809 791.0376

Table 3 (continued) Part B

Name and Title of Director	Year established	Primary Interest
Dr. J. Vicente-Chandler Director	1949	Agronomy, soils, productivity
Dr. A. Sotomayor-Rios, Director	1901	Plant research
Carlos G. Troche, State Executive Director	1933	Conservation, Commodity support
William L.Manning, Area Dir Area Director	Not given	Prevention of plant diseases
Dr. Thomas J. Holt, Area Veterinarian-in-charge	Not given	Prevention of animal diseases
Julia R. de Vincenti, State Director	1935	Rural development of all kinds
Jaime O Rivera, Area Director	Not given	Food assistance Program
Juan E. Munoz, Forest Supervisor	1903	Management of national forest
Dr. Ariel E. Lugo, Director	1939	Forestry research
J D Willis Regional Director	1971	Meat and poultry inspection
Jerome E. Arledge, State Director	1935	Soil and water conservation
Peter Tweedt, Director	1972	Coastal resource management
Omar Munoz-Roure, Executive Director	1976	Manage regional fisheries
Dr. Jose Colon Meteorologist	1899	Monitor and forecast weather

Table 3 (continued) Part C

Secondary Interest	Kinds of Activity	Kinds of Support
None stated	Research, in-house	None
Germ-plasm conservation	Research, in-house	Limited cooperative program
Environmental protection, emergency support	Projects	Matching grants, technical assistance
Pest detection, surveys	Technical assistance	In-kind services
None stated	Technical assistance	In-kind services
Community facilities	Projects	Grants, loans, loan guarantees
Promote food production	Research, projects	Grants, matching grants
Assistance for state forestry program	Agency operations, cooperative agreements	Technical assistance
International forestry collaborative projects	Research, in-house technical assistance	In-kind services, consultation
None stated	Agency operations; project implementation	None stated
Environmental education	Technical assistance project implementation	In-kind services, consultation
Economic development	Research, tech assist, small projects	Grants, in-kind services
Habitat conservation	Research, tech assist, project implementation	Grants, in-kind services
Maintain weather records	Agency operations	Technical advice

Table 3 (continued) Part D

Fund Sources	Area Served	Research Clients
Govt budget	Puerto Rico only	Individuals, public agencies, academic institutions
Govt budget	Caribbean region	All sectors benefit from research
Govt budget	Puerto Rico & USVI	None
Govt budget	Puerto Rico & USVI	None
Govt budget	Puerto Rico & USVI	None
Govt budget	Puerto Rico only	None
Govt budget	Puerto Rico & USVI	Public agencies
Govt budget	Puerto Rico only	Individuals, public agencies, acad. inst, non-profit organizations
Govt budget	Western hemisphere	Individuals, public agencies
Govt budget	Puerto Rico & USVI	None
Govt budget	Puerto Rico & USVI	None
Govt budget	Puerto Rico & USVI	Public agencies
Govt budget	Puerto Rico & USVI	Educational institutions, public agencies
Govt budget	Puerto Rico & USVI plus other islands	None

Table 3 (continued) Part E

TechAssist Clients	Project Clients
None identified	None identified
None identified	None identified
Related to projects	Individuals, companies, non-profit organizations
All sectors	All sectors
All sectors	All sectors
None	Individuals, NPOs, public agencies, companies
None	Public agencies
All sectors	Individuals, public agencies
Individuals, public agencies	None
Public agencies	Individuals, non-profit organizations, companies
Ind, public agencies, NPOs, educational inst	Soil conservation districts
Public agencies	Public agencies
All sectors	None
All sectors	None

Table 3 (continued) Part F

Summary of Last Year Activities

Research on soils and crop management related plantains, bananas, rice and cocoa on humid hill lands

Winter nursery support for mainland research activities, continuing studies of plant genetics

Conservation and environmental improvement through support for better farm practices

Inspection of cargo for plant diseases

Inspection of animals, cooperative disease control programs

Low income rural housing, community facilities, rural business and industry, farm operating support

Food support (cash and in-kind), some production assistance

Forest management, technical assistance for forest research, technical assistance to PR Forest Service for reforestation

Research in forest ecology and timber management; support for recovery program for endangered PR parrot

Meat and poultry inspection at slaughterhouses

Reduce soil erosion, conserve and improve water quality, reduce flood damage

Implement state coastal management programs, support for estuarine sanctuaries, and related activities

Develop and monitor regional fishery management plans; negotiate international fishery rights

Monitor atmospheric conditions, forecast weather for general public, aviation and marine interests

Table 3 (continued) Part G

Major Role	Constraints
Research on crop management on tropical soils, for production and conservation	Replace retiring scientists with well-trained, motivated young staff
Develop sound agricultural practices, conserve germplasm for future use	Limited funding for tasks identified
Support production, avoid loss of soil, abate pollution, improve farm practices	Limited client cost sharing ability hinders optimum use of resources
Protection of mainland agriculture	Limited funding and staff
Protection of public health	Limited funding and staff
Credit source of last resort for low income farmers and rural communities	Limited sewerage in rural areas does not permit full use of resources
Support for low income persons	Legislative ceiling on funds for PR
Management of national forest, plus support for local forestry	Limited funding related to potential opportunities and tasks
Support for sound forest practices	Limited funding, lack communication with potential users of products
Improve meat production related to human health	Funding cutbacks
Provide leadership for soil and water conservation practices and programs	Limited ability of clients to make efficient use of SCS resources
Identify & protect sites for water dependent economic activities	Limited funding, lack of local interest
Conserve fishery resources while permitting continued economic use	Limited funding; lack of data
Improve data gathering and forecasting to protect lives and property	Lack of real-time information on weather conditions

Table 3 (continued) Part H

Opportunities	Potential Impacts
Expanded, accelerated research related to needed improvements in local agriculture	Introduction of new crops, improved productivity of traditional crops
Recruit additional scientists and support staff for tropical research	Assist farmers to improve economic return from agricultural activities
None, because of proposed cutbacks	Not possible to speculate
Staff and equipment for inspection stations	Improved protection for US agriculture
Trained staff and equipment	Improved public health
Development of priorities for optimum use of funds assigned to PR	Economic viability of small farms, adequate housing and services
Additional funds	Service to all who qualify
Added recreation facilities, acquire more land, protect soil and water resources	Attract visitors, preserve water quality, protect endangered species
Closer liaison with forestry authorities throughout the region	Focus research on regional needs; expand personnel interchange
Cooperation and understanding from Congress to improve inspection services	Improved consumer protection
Target available resources for most critical areas in the region	Improve soil and water conservation, restore essential croplands
Obtain permanent basis for funding, maintain program status	Provide continuing support for state coastal program activities
Identify and resolve problems related to fishery habitat	Expansion of small scale fisheries
Improve flash flood warning capability	Improved forecasting of special weather hazards

Table 3 (continued) Page 2

Agency and program	Location
Dept of Commerce - NOAA (continued)	
National Sea Grant College Program	Washington, DC
DEPARTMENT OF DEFENSE; ARMY	
Corps of Engineers, Jacksonville District San Juan Area Office	400 Fernandez Juncos Av, San Juan, PR
DEPARTMENT OF THE INTERIOR	
Fish and Wildlife Service	
Caribbean Area Office	Hwy 301, Km 5.1, Cabo Rojo, PR
Caribbean Islands National Wildlife Refuge	Hwy 301, Km 5.1, Cabo Rojo, PR
Law Enforcement Office	Mayaguez, PR
Geologival Survey	
Geology Division	DNR, Fdz Juncos Av, San Juan, PR
Water Resources Division	Bldg 651, GSA Ctr, Ft. Buchanan, PR
National Park Service	
San Juan National Historic Site	Fort El Morro, San Juan, PR
Virgin Islands National Park	St. John, USVI
DEPARTMENT OF TRANSPORTATION : COAST GUARD	
Coast Guard-Greater Antilles Section	CG Base, La Puntilla, San Juan, PR
ENVIRONMENTAL PROTECTION AGENCY	
Caribbean Area Office	Fdz Juncos Ave, Pda 20 Santurce, PR
FEDERAL EMERGENCY MANAGEMENT AGENCY	
Disaster Field Office (FEMA 746-DR-PR)	Mercantile Plaza, Hato Rey, PR

Source of information: Questionnaire and personal interviews supplemented by budgets, reports, etc.

Table 3 (continued) Page 2, Part A

Mail Address	Area Code/ Telephone
Washington, DC 20235	
Fernandez Juncos Av 400, San Juan, PR 00901	809 723.0133
PO Box 510, Boqueron, PR 00622	809 834.4440
PO Box 510, Boqueron, PR 00622	809 851.3637
Mayaguez,PR 00708	809
PO Box 5917, San Juan, PR 00906	809 722.3142
GPO Box 4424, San Juan, PR 00936	809 754.4414
PO Box 712, San Juan, PT 00902	809 724.1974
PO Box 7789, C. Amalie St Thomas, USVI 00801	809 775.6238
PO Box S 3666, San Juan, PR 00904	809 725.0857
Fdz Juncos Av 1413m, Santurce, PR 00910	809 725.7825
Stop 27.5, P de Leon Av. Hato Rey, PR 00919	809 753 2467

Table 3 (continued) page 2, Part B

Name and Title of Director	Year Established	Primary Interest
		Sustain graduate program in marine science and research
LCL C T Myers III, District Engineer	1884	Civil works related to water resources
Paul E. Gertler, Field Superviser	1940	Protect endangered species; conserve habitat
Sean Furniss, Refuge Manager	1940	Wildlife and habitat management
Ricardo Cotte,		Regulation of exotic species import & export
Rafael Rodriguez, Director	1972	Explore and map PR insular shelf
Ferdinand Quinones, District Chief	1957	Water resources investigation
W. P. Crawford, Superintendent	1935	Operate historic site for public education
Noel J. Pachta, Superintendent	1956	Operation of national parks in US Virgin Islands
Cdr D E Bodron, Commander	not given	Marine safety, environmental protection
Pedro Gelabert, Area Director		Environmental protection
Curtis R. Carleton, Fiueld Director	1985	Disaster relief assistance

Table 3 (continued) Page 2, Part C

Secondary Interest	Kinds of Activity	Kinds of Support
Public education and marine extension service	Research, Tech assist, project implementation	Grants
Military support; tech assist to govt agencies	Agency operations	In-kind services, advice, permits
Fish and wildlife resource issues	Research; projects; technical assistance	Grants, in-kind services
Environmental education	Agency operations; technical assistance	In-kind services
None	Agency operations	In-kind services
Explore & map insular shelf of Dominican Rep.	Research; agency operations	Scholarships
Geology	Agency operations; technical assistance	Grants; in-kind services
Study human and natural impacts on historic site	Agency operations	In-kind services
None stated	In-house research	Contract research
Navigation aids; search & rescue	Agency operations	Materials, in-kind services
Env. education	Research, projects technical assistance	Grants, in-kind services
Hazard mitigation	Technical assistance, projects	Matching grants

Table 3 (continued) Page 2, Part D

Fund Sources	Area Served	Research Clients
Govt budget	Puerto Rico	Educational institutions
Govt budget	Puerto Rico & USVI	None
Govt budget	Puerto Rico & USVI	Non-profit org, public agencies, educational institutions
Govt budget	Puerto Rico & USVI	None
Govt budget	Puerto Rico only	None
Govt budget; contracts	Caribbean region	Public agencies, educational institutions
Govt budget; contracts	Puerto Rico & USVI	Public agencies, educational institutions
Govt budget	Puerto Rico only	None
Govt budget	USVI only	Research contracts awarded on basis of proposals
Govt budget	Puerto Rico & USVI	None
Govt budget	Puerto Rico & USVI	Public agencies, individuals
Govt budget	Puerto Rico only	None

Table 3 (continued) Page 2, Part E

TechAssist Clients	Project Clients
Educational Inst	Educational inst
Public agencies	Public agencies; individuals
All sectors	All sectors
All sectors	None
None	None
None	None
None	None
Individuals, public agencies, ed inst	None
All sectors	None
None	None
Individuals, companies	None
Public agencies, companies	Public agencies
Public agencies	Individuals, public agencies, educ. inst.

Table 3 (continued) Page 2, Part F

Summary of Last Year Activities

Support for research, marine biology, educational programs, medical applications, etc.

Harbor channel maintenance; project planning and construction, protect wetlands and navigable waters, issue permits

Endangered species research and recovery, evaluate impact of development projects on fish, wildlife, and wetlands

Management programs for selected species of birds, turtles; development of visitor information facilities

Inspect shipments of animals, investigate complaints

Cooperative marine geology studies of PR insular shelf, identification of submarine sand deposits, etc.

Investigate north coast aquifer in PR; maintain water well inventory and records; record water characteristics

Maintain and restore historic structures and exhibits

Eleven projects related to coral reefs and fisheries within the national parks

Coordinate cleanup of spills of petroleum and hazardous waste; boating safety education activities; search & rescue

Monitoring water quality, water pollution control projects

Distributiuon of funds for rehabilitation and restoration of public facilities and private property after disaster

Table 3 (continued) Page 2, Part G

Major Role	Constraints
Improve public awareness, promote scientific knowledge	Funding limitations
Develop projects related to water resources management	National priorities may not be compatible with local ones
Protect wetlands and endangered species	Limited funding, personnel for work to be done
Preserve and protect natural resources for public benefit	Limited funding, personnel; lack of interest
Protect native species	Limited funding, personnel
Identification of submerged sand to substitute for coastal sand sources	Limited funding, personnel
Provide and interpret basic data for public policy decisions	Limited funding
Interpret historic value	Limited funding
Maintain resources and interpret them for public benefit	None stated
Protect marine environment; promote boating safety	Funding, personnel, training
Protect environment	Funding, personnel, training
No direct interest	None

Table 4. FEDERAL AGENCY RESEARCH, EDUCATION, REGULATORY AND SUPPORT OR ASSISTANCE PROGRAMS IN THE U.S. CARIBBEAN

Agency	Research	Educate	Regulate	Support /Assist
DEPARTMENT OF AGRICULTURE				
Agricultural Research Service	X			
Tropical Agriculture Research Station	X			
Forest Service				
Caribbean National Forest	X			
Institute of Tropical Forestry	X			
Cooperative Extension Service		X		X
Soil Conservation Service		X		X
Ag. Stabilization and Conservation Service				X
Animal and Plant Health Inspection Service			X	
Meat and Poultry Inspection Service			X	
Farmers Home Administration				X
Food and Nutrition Service				X
DEPARTMENT OF COMMERCE				
National Oceanic and Atmospheric Administration				
Office of Ocean and Coastal Resources Mgt	X	X		X
National Marine Fisheries Service				
Caribbean Fisheries Management Council			X	X
National Sea Grant College Program	X	X		
National Weather Service				X
DEPARTMENT OF THE INTERIOR				
Fish and Wildlife Service				
Caribbean Field Office			X	
Caribbean Islands National Wildlife Refuge	X	X		X
Law Enforcement Office			X	
Geological Survey				
Geology Division	X			X
Water Resources Division	X			X
National Park Service				
Virgin Islands National Park	X			
DEPARTMENT OF TRANSPORTATION				
Coast Guard, Marine Safety Office			X	
DEPARTMENT OF DEFENSE - ARMY				
Corps of Engineers, Jacksonville District			X	X
ENVIRONMENTAL PROTECTION AGENCY	X	X	X	X
FEDERAL EMERGENCY MANAGEMENT AGENCY	X			

Table 5. FUNDING FOR FEDERAL PROGRAMS RELATED TO RENEWABLE RESOURCES IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS
Fiscal Years 1982 - 1984
($000)

Program/Jurisdiction	FY 1982	FY 1983	FY 1984
PART A. FEDERAL GOVERNMENT GRANTS TO STATE AND LOCAL GOVERNMENTS			
Total Grants			
United States	88221369	92711695	97208631
Puerto Rico	1397295	2110626	2231139
Virgin Islands	116427	91390	136803
Agriculture, Total			
United States	6705239	8739915	9345980
Puerto Rico*	376075	993127	1012674
Virgin Islands	7192	10609	11395
Agricultural Extension Service			
United States	280506	338031	306918
Puerto Rico	6485	6475	5104
Virgin Islands	170	670	413
Agriculture Marketing Service			
United States	No data	542440	438954
Puerto Rico	No data	575	1056
Virgin Islands	No data	0	0
Agricultural Research Service			
United States	No data	No data	7696
Puerto Rico	No data	No data	50
Virgin Islands	No data	No data	50
Commodity Credit Corporation - Price Supports			
United States	No data	1373000	1066576
Puerto Rico	No data	33677	6698
Virgin Islands	No data	1365	1276
Cooperative State Research Service - Agricultural Experiment Station			
United States	179721	184266	189684
Puerto Rico	3471	3629	2911
Virgin Islands	0	209	508
Farmers Home Adm - Rural Development Planning, Water and Sewer Programs			
United States	216876	161133	134338
Puerto Rico	3798	2522	5911
Virgin Islands	6	4	25

Table 5 - Page 2

Program/Jurisdiction	FY 1982	FY 1983	FY 1984
Food and Nutrition Service - All Food Programs			
United States	4599899	5756378	6748047
Puerto Rico*	271008	945886	990412
Virgin Islands	29714	8337	9069
Forest Service - All Programs			
United States	278426	180825	223282
Puerto Rico	188	166	251
Virgin Islands	26	24	26
Meat and Poultry Inspection Service			
United States	29237	29858	31772
Puerto Rico	0	0	0
Virgin Islands	0	0	0
Soil Conservation Service, including Resource Conservation & Development			
United States	162011	149627	168436
Puerto Rico	724	113	222
Virgin Islands	0	0	0
Commerce - NOAA - Coastal Zone Management			
United States	43406	54072	30866
Puerto Rico	1460	1131	363
Virgin Islands	532	544	236
Interior - Fish and Wildlife Service			
United States	154446	155785	151306
Puerto Rico	1011	695	627
Virgin Islands	409	234	348
Interior - Land and Water Conservation Fund			
United States	211308	154438	167295
Puerto Rico	2721	1853	2705
Virgin Islands	62	235	25
Environmental Protection Agency			
United States	4043811	3257317	2869661
Puerto Rico	53021	21805	18454
Virgin Islands	800	1206	580
TOTAL GRANTS RELATED TO IDENTIFIED RENEWABLE RESOURCE PROGRAMS			
United States	16904886	21077085	21880811
Puerto Rico	719962	2011654	2047438
Virgin Islands	38911	23437	23951

* = Data for FY 1983 and FY 1984 include special food program grant to Puerto Rico in lieu of direct payments to individuals

Table 5 - Page 3

Program/Jurisdiction	FY 1983	FY 1983	FY 1984
PART B. FEDERAL LOAN AND INSURANCE PROGRAMS			
Commodity Loans - Price Supports			
United States	13747387	13753944	4742576
Puerto Rico	743	449	129
Virgin Islands	0	0	0
Farmers Home Adm - Farmer Programs			
United States	4113863	3760332	4854348
Puerto Rico	18417	9971	21374
Virgin Islands	37	0	195
Crop Insurance			
United States	21867770	19300765	11013433
Puerto Rico	0	0	0
Virgin Islands	0	0	0
Rural Electric and Telephone Loan Guarantees			
United States	No data	4589457	2115949
Puerto Rico	No data	56848	45839
Virgin Islands	No data	0	0
PART C. DIRECT PAYMENTS TO INDIVIDUALS			
Food and Nutrition Service - Food Stamp Program			
United States	10222310	11061102	10690850
Puerto Rico*	671198	-12	-49
Virgin Islands	19844	23402	24101

* = Data for FY 1983 and FY 1984 include special food program grant to Puerto Rico in lieu of direct payments to individuals

Source: US Dept of Commerce, Bureau of the Census:
Federal Expenditures by State, 1982-1984

Table 6. INSULAR GOVERNMENT AGENCIES INVOLVED WITH RENEWABLE RESOURCES IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS

Agency and Program Activity	Location
COMMONWEALTH OF PUERTO RICO	
LEGISLATIVE ASSEMBLY	
Senate Committee on Agriculture and Natural Resources	Capitol Building, San Juan, PR
House Committee on Natural Resources and Environmental Quality	Capitol Building. San Juan, PR
OFFICE OF THE GOVERNOR	
Environmental Quality Board	Calle del Parque 204, Santurce, PR
Puerto Rico Planning Board	Minillas Govt Center Santurce, PR
EXECUTIVE AGENCIES	
Department of Agriculture	
Central Office	Fdz Juncos Av, Stop 19, Santurce, PR
Soil Conservation Committee for PR	Fdz Juncos Ave, Stop 19, Santurce, PR
Agricultural Development Admin.	Hipodromo Av 603, Santurce, PR
Sugar Board of PR	Hipodromo Av 603, Santurce, PR
Department of Natural Resources	
Central Office, including Areas of Flood Control, Planning, Research, Resource Administration, Ranger Corps	Ponce de Leon Av, Stop 3, San Juan, PR
Coastal Zone Management Office	Ponce de Leon Av, Stop 3, San Juan, PR
Corp for the Development of the Marine, Lacustrine and Fluvial Resources of PR	Ponce de Leon Av, Stop 8 San Juan, PR
Culebra Conservation & Development Auth	San Ildefonso, Culebra

Table 6 (continued) Part A

Mail Address	Area Code/ Telephone
Capitol Building, San Juan, PR 00901	809 725.9196
Capitol Building, San Juan, PR 00901	809 722.4437 809 722.1435
PO Box 11488, Santurce, PR 00910	809 721.2120
PO Box 41119 Santurce, PR 00940	809 727.4444
PO Box 10163, Santurce, PR 00908	809 721.2120
PO Box 10163, Santurce, PR 00908	809 725.3040
PO Box 9200, Santurce, PR 00908	809 723.8526
PO Box 8727, Santurce, PR 00910	809 722.1847
PO Box 5887, San Juan, PR 00906	809 724.8774
PO Box 5887, San Juan, PR 00906	809 724.5516
PO Box 2629, San Juan, PR 00903	809 725.7200
PO Box 217, Culebra, PR 00645	809 742.3225

Table 6 (continued) Part B

Name and Title of Director	Year Established	Primary Interest
Sen. Justo A. Mendez Chairman	1917	Agriculture, Natural Resources
Rep. Andres Colon-Marrero, Chairman	not given	Natural Resources, Environmental quality
Santos Rohena, Jr President	1970	Establish and monitor public environmental policy
Patria Custodio, PE President	1942	Establish and implement development policy
Juan Bauza-Salas Secretary	1917	Develop or rehabilitate all agricultural sectors
Filiberto Matias, Executive Secretary	1946	Soil conservation
Juan A. Rodriguez, Executive Director	1985	Economic incentives to increase agricultural production
Guillermo Esteves, Jr. President	1951	Sugar industry of Puerto Rico
Alejandro Santiago-Nieves Secretary	1973	Balanced management/development of all natural resources
Jose Gonzalez-Liboy Program Manager	1978	Conservation and management of coastal resources
Ivan Sanchez-Ayendez, Executive Director	1979	Promote fisheries
Alejandro Santiago-Nieves Board Chairman	1975	Conserve and develop natural resources of Culebra Island

Table 6 (continued) Part C

Secondary Interest	Kinds of Activity	Kinds of Support
Energy conservation	Govt operations, projects	Legislative programs and appropriations
None stated	Govt operations, projects	Legislative programs and appropriations
Support/monitor sewage plant construction	Research, Technical assistance	In-Kind services
Guide public investment in programs and projects	Research; technical assistance	In-Kind services; technical assistance
Assure fair income, promote employment	Research, projects technical assistance	Grants, materials, loan guarantees
None stated	Technical assistance	Grants
None stated	Projects	Economic support
None stated	Technical assistance	In-Kind services
Hazard mitigation and public awareness	Agency operations	In-Kind services, materials, advice
Sites for water dependent economic activity	Research, technical assistance, projects	Grants, in-Kind services
Aquaculture	Research, projects technical assistance	Grants, materials, in-Kind services
Provide passive public recreation facilities	Projects, technical assistance	In-Kind services

Table 6 (continued) Part D

Funding Sources	Area Served	Research Clients
Govt budget	Puerto Rico only	Public Agencies
Govt budget	Puerto Rico only	Public agencies
Govt budget	Puerto Rico only	None
Govt budget	Puerto Rico only	Public agencies
Govt budget contributions	Puerto Rico only	Public agencies
Govt budget	Puerto Rico only	None
Govt budget	Puerto Rico only	None
Govt budget	Puerto Rico only	None
Govt budget, contracts	Puerto Rico only	Public agencies
Govt budget	Puerto Rico only	Public agencies
Govt budget	Puerto Rico only	non-profit organizations
Govt budget	Puerto Rico only	None

Table 6 (continued) Part E

Technical Assist Clients	Project Clients
None	Public agencies individuals, companies
None	Public agencies, individuals, companies
Individuals, NPOs public agencies	None
All sectors	Public agencies
Public agencies, coops, individuals	Public agencies
None	Public agencies
None	Public agencies, individuals
None	Public agencies, individuals
Individuals, public agencies	Individuals, public agencies
Public agencies	Public agencies
All sectors	Individuals, non-profit organizations
Individuals, NPOs, public agencies	Individuals, NPOs, public agencies

Table 6 (continued) Part F

Summary of Last Year Activities

Legislative action on proposals and budgets related to agriculture and natural resources

Legislative action on proposals and budgets related to natural resources and environmental quality

Implement pollution control programs for air, water, noise, hazardous wastes

Provide socioeconomic assessment for Governor and Legislative Assembly as basic for public policy

Promote improvement of agricultural production and marketing, plus quality of rural environment

Promote soil conservation practices and projects through 17 local soil conservation districts

Incentives and income guarantees to maintain rural labor force for farm operations

Enforce laws and regulations related to sugar industry; adjudicate controversies between growers and processors

Reforestation, flood control, fisheries support, hazard mitigation plans and implementation, refuge management

Resource management, protection of critical areas, hazards mitigation, public education

Research on fishery matters, construction of support facilities, training, collect statistics onfishing

Evaluate requests for peremits and connections, promote environmentally sound development

Table 6 (continued) Part G

Major Role	Constraints
Reviewing legislative proposals and keeping statutes up to date	Resources, manpower, existing public policies
Review legislative proposals and keeping statutes up to date	Finances
Promote environmentally compatible development	Funding limitations, shortage of trained, experienced personnel
Coordinate public and private sector development programs and projects	Lack of timely socioeconomic report by public and private sectors
Improve farm productivity and preserve farmland	Funding limitations, pressure for land use changes
Control erosion, increase farm productivity	Lack of qualified supervisors
Provide economic resources for farm operations	Funding limitations
Maintain the viability of the sugar industry	None stated
Promote economic development within context of resource conservation	Funding limitations, lack of information on natural resources
Identify critical areas, develop plans for management, public education	Funding limitations; lack of permanent program status
Monitor resources, develop new alternatives for fishermen	Funding limitations
Protect, conserve and develop the resources of Culebra	Funding limitations, squatters on public lands, lack of sewerage

Table 6 (continued) Part H

Opportunities	Potential Impacts
Improve agricultural production and conserve natural resources	Enhance self-sufficiency and provi products for export
Create volunteer advisory panels, improve understanding of need to protect resources	Improve existing statutes; protect natural resources
Delegate responsibility for EPA programs in Puerto Rico	Improve environmental quality by more effective monitoring
Improve laws on socioeconomic data reporting; recruit technical staff	Increase productivity; permit time publication of reliable statistics
Improve marketing mechanisms to encourage production and generate farm employment	Improve production for local marke and for export; improve quality
Recruit new properly trained personnel	Expand program and control erosion
Increase legislative appropriations	Generate additional agricultural employment
Additional funds would permit more effective regulation	Increased economic benefits for cane growers and processors
Funds for land acquisition, additional staff, reforestation	Protection of critical land areas, more effective resource managemen
Institutionalization of Coastal Management Office	Enhanced coordination and promoti of coastal activities
Access to new funding sources	Reduce reliance on imports, suppor viable local fishing industry
Obtain reliable source of revenue, train technical staff	Promote appropriate infrastructure generate economic benefits

Table 6 (continued) Page 2, Part F

Summary of Last Year Activities

Review subdivision and construction plans; issue construction and use permits

Authorized $4.4 million in aid to 18 cooperatives

Provide loans and loan guarantees for agriculture

Support and guide development through public bond issues and loans for programs and projects in the public interest

Provide long term financing for commerce, industry, and service activities

Provide long term financing at reduced interest rates for new investment in various kinds of facilities

Cultivate and process pineapple products;
Cultivate rice and vegetables; lease and sell land

Conservation/development of Rio Camuy caves; lease of Humacao lagoons to DNR for natural reserve

Operate five sugar mills and one refinery

Delimit zone of tourist interest; promote enjoyment and and preservation

Provide potable water, operate sewage treatment systems, comply with RPA water pollution control stanmdards

Supply irrigation water to South Coast, Lajas Valley and Isabela Irrigation Districts

Promote family type farms in coffee region and provide supporting rural infrastructure

Planningislandwide resource recovery system with regional facilities; system not yet operational

Table 6 (continued) Page 2, Part G

Major Role	Constraints
Assure provision of appropriate infrastructure in subdivisions	Funding limitations; lack of staff
Agricultural cooperatives are among the clients of this agency	None stated
Finance agricultural operations and improvements	None
Finance public and private infrastructure for pollution control and abatement	Funding limitations for Federal programs
None stated	None stated
None stated	None stated
Apply most advanced techniques to production, processing and marketing	Economics
Support for other public agencies	None stated
Maintain 3600 direct jobs and sustain 11000 indirect jobs in sugar	Low sugar price in world market
Promotion and protection	Incompatible land uses; lack of infrastructure and incentives
Provide adequate potable water supply and maintain sewer systems	Rapidly growing demand for services generated by urban expansion
Maintain and operate irrigation system, including dams and canals	Sedimentation of reservoirs; age of major structures
Encourage family farm practices approved by College of Agriculture, UPR	None stated
Develop and operate solid waste and resource recovery system	Funding limitations, lack of community acceptance

Table 6 (continued) Page 2, Part H

Opportunities	Potential Impacts
Recruit trained technical staff	Expedite processing of permits, improve field inspections
None stated	None stated
Increased resources	Expand level of activity
More effective use of all fiscal programs and resources	Further action on renewable energy resources and environmental controls
None stated	
None stated	None stated
Economic and technical assistance	Increase production
Obtain funding to expand cave project	Conserve ecological rarity; promote tourism and economic activity
None unless sugar price increases	Higher sugar price will permit expansion of activity and jobs
Improve tourism investment incentives; obtain appropriate zoning for tourism	Increase tourism capability; ensure desirable standards of quality
Complete regional sewer systems; upgrade maintenance	Protect water quality, assure public health
None stated	None stated
None stated	None stated
Appropriate public and private sector support to get under way	Effective resolution of solid waste problem for the island

Table 6 (continued) Page 3

Agency and Program Activity	Location
TERRITORY OF THE VIRGIN ISLANDS OF THE UNITED STATES	
EXECUTIVE AGENCIES	
Department of Agriculture	Christiansted, St. Croix, USVI
Dept of Conservation & Cultural Affairs	
Coastal Zone Management Program	Altona 129, C. Amalie St. Thomas, USVI
Division of Fish and Wildlife	Estate Nazareth, St. Thomas, USVI

Table 6 (continued) Page 3, Part A

Mail Address	Area Code/ Telephone
PO Box U, Kingshill, St Croix, USVI 00850	809 778.0991
PO Box 4399, St. Thomas, USVI 00801	809 774.3320
Estate Nazareth 11, Red Hook St Thomas, USVI 00802	809 775.6762

Table 6 (continued) Page 3, Part B

Name and Title of Director	Year Established	Primary Interest
Patrick N. Williams, Commissioner	1966	Agricultural services
Benjamin I.Nazario, Director	1979	Protection and management of coastal zone of USVI
Dr. David W. Nellis Chief	1970	Research and surveys of VI fish and wildlife

Table 6 (continued) Page 3, Part C

Secondary Interest	Kinds of Activity	Kinds of Support
Technical assistance	Technical assistance, project development	Direct and matching grants
Development studies	Research, technical assistance	In-Kind services
Technical guidance for development	Research, technical assistance, projects	None

Table 6 (continued) Page 3, Part D

Funding Sources	Area Served	Research Clients
Govt budget	USVI only	None
Govt budget	USVI only	Educational institutions, public agencies
Govt budget, contracts	USVI only	Public agencies

Table 6 (continued) Page 3, Part E

Technical Assist Clients	Project Clients
Individuals, coops, companies, ed inst	Individuals, coops companies, ed inst
Educ inst, public agencies, companies	Educ inst, public agencies, companies
All sectors	None

Table 6 (continued) Page 3, Part F

Summary oo Last Year Activities

Services provided in areas of food production, soil and water conservation, forestry, veterinary health

Review permit applications, develop mooring plans, review five area management plans in St Thomas and St Croix

Research and surveys of USVI seabirds, wildlife and endangered species, collection of fisheries data

Table 6 (continued) Page 3, Part G

Major Role	Constraints
Develop, promote, and implement new ideas and programs for agriculture	Funding limitations restrict purchase of materials, equipment
Promote conservation and wise use of coastal resources, public education	Funding limitations, lack of staff, bureaucratic delays
Promote conservation of fish and wild life resources of the USVI	Funding limitations, lack of qualified technical staff

Table 6 (continued) Page 3, Part H

Opportunities	Potential Impacts
Increased appropriations	Expand services and programs
Recruit additional trained staff	Improve coastal management, provide guidance for public policy
Separate local programs from federal projects, recruit added staff	Improved resource management

Table 7. INSULAR GOVERNMENT FUNDING RELATED TO RENEWABLE RESOURCES PROGRAMS IN PUERTO RICO

(Fiscal Years 1984 - 1986)
($000)

Program/Jurisdiction	FY 1984 Spent	FY 1985 Budgeted	FY 1986 Recommended
Environmental Quality Bd	7304.6	7995.7	6572.4
Planning Board	6737.9	6782.8	6442.1
Permits & Reg Adm	6434.7	6434.7	6134.7
Dept of Agriculture	9399.0	8878.6	8470.9
Agricultural Dev Adm	122955.4	121996.7	118938.4
Farm Credit Corp	16748.3	22873.6	18450.0
Land Authority	25817.5	27712.6	28532.5
Milk Industry Reg Bd	133.2	135.3	135.3
Rural Development Corp	7277.5	4800.5	4921.2
Sugar Board	266.2	266.2	130.0
Sugar Corp	126343.3	166812.0	179751.4
PREPA Irrigation Div	4777.0	4470.0	4534.0
UPR Agricultural Exp Sta	9472.8	9525.7	9525.7
UPR Agricultural Ext Svc	11198.9	13231.4	11898.8
UPR Tropical Ag Exp Sta	125.0	125.0	125.0
Dept of Natural Resources	18125.3	15562.8	16394.5
Admin & Management	4882.5	5140.9	4972.9
Flood Control	535.9	591.7	588.3
Forest, Sanct & Reserves	2683.8	3154.0	2422.1
Operations	4820.8	5119.7	4704.3
Resource Planning	1330.7	1543.4	1209.5
Ranger Corps	2558.9	2155.2	1495.3
Research	1312.7	1011.9	1002.1
CODREMAR	1127.0	1105.0	1105.0
Culebra Cons & Dev Auth	186.9	186.9	186.9
Coop Dev Adm	1936.0	1816.0	1776.0
Govt Dev Bank	285248.4	340676.9	364491.0
Land Administration	2081.5	1848.5	1468.7
PR Aqueduct & Sewer Auth	281908.8	305145.3	375953.7
Tourism Company	15632.6	16049.7	15500.8

Source: Governor's Executive Budget, FY 1986

Table 8. ACADEMIC INSTITUTIONS INVOLVED WITH RENEWABLE RESOURCES IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS

Organization Name and Program	Location
UNIVERSITY OF PUERTO RICO	
Agricultural Experiment Station	Rio Piedras
Botanical Garden	Experimental Station Rio Piedras
Center for Energy & Environmental Research (CEER)	Medical Campus Rio Piedras
Department of Marine Sciences	Mayaguez Campus, Mayaguez
COLLEGE OF THE VIRGIN ISLANDS	
Caribbean Research Institute	St Croix and St Thomas
Water Resources Research Center	St. Thomas
Cooperative Extension Service	St. Croix campus
Marine Advisory Service	St. Thomas campus
Virgin Islands Ecological Research Station (VIERS)	Lameshur, St John

Table 8 (continued) Part A

Mail Address	Area Code / Telephone
GPO Box 21360 San Juan, PR 00936	809 767.9205
GPO Box 4984 San Juan, PR 00936	809 767.1710
GPO Box 3682 San Juan, PR 00936	809 767.0350
University Station Mayaguez, PR 00708	809 832.3585
CVI, St. Thomas US Virgin Islands 00802	809 776.9200
CVI, St. Thomas US Virgin Islands 00802	809 776.9200
CVI, PO Box L, Kingshill St. Croix, USVI 00850	809 778.0246
CVI, St. Thomas US Virgin Islands 00802	809 776.9200
PO Box 429, Cruz Bay St. John, USVI 00830	809 776.6721

Table 8 (continued) Part B

Director	Year Established	Primary Area of Interest
Dr. Jesus Roman Director	1910	Research on soils, crops, livestock and fisheries
Arturo Roque Doirector	1969	Passive recreation,education
Dr. Juan A. Bonnet, Jr. Director	1976	Research into energy and environmental matters
Dr. Manuel Hernandez-Avila, Director	1968	Marine sciences; oceanography
Dr. William A. Harris Assistant Director	1965	Applied research in physical and social sciences
Dr. Henry H. Smith Coordinator	Not stated	Applied research
Dr. Darshan S. Padda Director	1974	Education and outreach on flora,fauna, environment
Dr. William P. MacLean	1984	Marine resources
Kirsten Canoy Manager	1967	Ecology of tropical systems

Table 8 (continued) Part C

Secondary Area of Interest	Activity Types	Types of Support
New technology for rum and foodstuffs	Agency operations	Technical advice
Plant ecology	Agency operations	Research, tech assist, project implementation
None stated	Research, technical assistance, projects	In-kind services
Aquaculture, fisheries	Research, technical assistance, projects	In-kind services. grants, scholarships
Conferences, training, publications	Research, technical assistance	In-kind services, materials
Conferences, publications	Research	In-kind services
Regional coordination to develop materials	Technical assistance	In-kind services
None listed	Research, technical assistance, projects	In-kind services, materials
Educational outreach	Research, technical assistance, projects	In-kind services, materials

Table 8 (continued) Part D

Fund Source	Area Served	Research Clients
Govt budget	Puerto Rico only	None stated
Govt budget	Puerto Rico only	Individuals, NPOs,public agencies, educational inst
Govt budget contracts contributions	Caribbean region, world-wide	All sectors
Govt budget contracts	World-wide	Individuals, Public agencies, educational institutions
Govt budget, grants, contracts	Caribbean region	Educational institutions, public agencies
Govt budget, grants	Caribbean region	Educational institutions, public agencies
Govt budget contributions	VI only	Individuals, NPOs,public agencies, educational inst
Govt budget	VI only	Companies, educational inst, public agencies
Contracts, Govt budget	World-wide	All sectors

Table 8 (continued) Part E

TechAssist Clients	Project Clients
None stated	None stated
Individuals,NPOs,public agencies,education inst	Ind,NPOs,public agencies,educ. inst
All sectors	All sectors
Individuals, public agencies, ed inst	Educational institutions
Educational inst, public agencies	None
Educational inst, public agencies	None
All sectors	None
All sectors	Public agencies
Individuals, ed inst public agencies	Companies, educational inst

Table 8 (continued) Part F

Summary of Last Year Program

None stated

Educational programs, published part of work on descriptive flora of Puerto Rico and adjacent islands

Energy-integrated dairy farm, Micro-seismic network; Biomass study, Insolation, Tropical forest carbon cycle, Edible crabs, etc

Education of marine scientists, research into marine-related matters, Sea Grant program, public education on marine matters

Ecology: natural resources data bank, mariculture of crustaceans; Social problems: poverty, substance abuse, justice system

Ground water research in St. Croix; water quality in St. Thomas; training seminars and water resources conference

Insect handbook; pasture survey; monitoring on St John; Advice to local farmers, residents, etc; public education programs

Advice to marine industries, coastal zone workshops, career counselling, develop marine affairs materials

Educational outreach on tropical ecosystems; research project for National Park Service, St John National Park

Table 8 (continued) Part G

Major Role	Constraints
Improve varieties of plants and local agricultural practices	None stated
Research in floristics, inventory and preserve endangered species	Funding limitations Lack of technical help
Specialized research support for agriculture and industry	Funding limitations
Marine-oriented education and research	Funding limitations
Catalog of resources; modelling changes due to development	Lack of trained staff, resources, coordination
Optimum development and management of VI water resources	Lack of interest in long term research
Improve environmental literacy	Funding limitations; insufficient staff
Research, advice, education concerning marine resources	Funding limitations
Support research; education for management	Funding limitations; lack of data base

Table 8 (continued) Part H

Opportunities	Potential Impacts
None stated	Improve productivity and economic benefits of farmers
Interchange with other Botanical gardens for conservation program	Create repository of endangered plants; educate public
Wider recognition of CEER as research center for PR and the Caribbean	High quality research, permanent staff, improved facilities
Create School of Marine and Atmospheric Sciences, Institute of Tropical Fisheries	Expand capability for education and related research
Extend activities at regional level; expand relations with Nat Park Svc.	Improve delivery of information within Caribbean region
Assured funding for long term research activities	Study of long term hydrologic cycles affecting the VI and Caribbean
Develop clearinghouse, expand role in education; regional interchange	Effective use of available skills; better coordination with schools
Limited only by funding	None stated
Increased budget, additional grants and endowment	Expanded research capability; increased public awareness

Table 9. LOCAL NON-GOVERNMENTAL ORGANIZATIONS INVOLVED WITH RENEWABLE RESOURCES IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS

Organization Name	Location
Agricultural Development Federation of Puerto Rico	Hwy 179, Barrio Carite, Guayama, P R
Agro-commercial Cooperative of Puerto Rico	San Miguel Ind Park, Santurce, P R
Borinquen Audubon Society	No office
Chamber of Commerce of Puerto Rico	100 Tetuan St, San Juan, P R
Conservation Trust of Puerto Rico	Banco Popular Bldg, San Juan, P R
Cooperative League of Puerto Rico	458 Calder St, Hato Rey, P R
Dairy Industry Development Fund	209 O'Neill St, Hato Rey, P R
Farm Credit Banks of Baltimore	213 Domenech St, Hato Rey, P R
Federal Land Bank Association of San Juan	Domenech 213, Hato Rey, P R
Future Farmers of America - Puerto Rico Association	Dept of Education, Hato Rey, P R
Garden Club of Puerto Rico	None
Horticultural Society of Puerto Rico	Hato Rey, P R
Humane Society of Puerto Rico	None
Industrias Avicolas de Puerto Rico	Coamo, P R
Natural History Society of PR	None
Puerto Rico Farm Bureau	Cond. San Martin, Santurce, P R

Table 9 (continued) Part A

Mail Address	Area Code/ Telephone
Rural Box 811, Carite, Guayama, P R 00654	809 758.0580
PO Box 331, San Juan, P R 00902	809 783.1646
306 Darlington Bldg, Rio Piedras, P R 00925	809 751.0177
PO Box 3789, San Juan, P R 00904-3789	809 721.6060
PO Box 4747, San Juan, P R 00905	809 722.3199
GPO Box 707, San Juan, P R 00936	809 764.2727
GPO Box 454, San Juan, P R 00936	809 765.7545
GPO Box 2856, San Juan, P R 00936	809 753.7321
GPO Box 3649, San Juan, P R 00936	809 753.0556
PO Box 759, Hato Rey, P R 00919	809 764.1125
GPO Box 88, San Juan, P R 00936	None given
GPO Box 4104, San Juan, P R 00936	809753.6911
PO Box 7242, Ponce, P R 00732	809 844.3488
PO BOX 229, Coamo, P R 00640	809825.2080
GPO Box 1036, San Juan, P R 00936	None
Ponce de Leon 1605, Santurce, P R 00909	809 721.5970

Table 9 (continued) Part B

Name and Title of Director	Year Established	Primary Area of Interest
Jorge Gaskins-Alcott, Executive Director	1978	Promote alternative agricultural development and employment
Ramon Colon Torres, President	1934	Aid former tobacco farmers to find alternative economic activities
Carlos R. Garrett, Chairman	1985	Protect flora and fauna
Rafael Rivera Rodriguez, Executive Vice President	1913	Promote economic development of PR under free enterprise principles
Francisco J Blanco, Executive Director	1970	Land acquisition for preservation
Felix J. Cristia-Martinez Executive Director	1948	Education
Dr Josep T. Marull, Executive Director	1957	Promote sale of dairy products
Alberto E. Burgos, Vice President	not given	Credit for farmers
Angel A. Portalatin, President	1922	Credit to farmers
Anselmo Miranda Adviser	1932	Promote youth interest in agriculture
Joan M Gandara, Acting President	1933	Urban beautification, protection of trees, plants, and birds
Sara G. Pagan, President	1970	Promote horticulture
None given	1967	Humane education, animal protection
Antonio Alvarez, President	1977	Commercial poultry processing
Dr. Frank H. Wadsworth, President	1960	Exploration, natural history and related education
Luis E. Torres-Rosa, President	1924	Promote agriculture

Table 9 (continued) Part C

Secondary Area of Interest	Types of Activity
Productive use of natural resources	Research, technical assistance, projects
Generate income and capital for support of members and cooperative	Technical assistance, projects
None stated	Technical assistance
None stated	Research, technical assistance
Public education, restoration program	Technical assistance, projects
None stated	Technical assistance
Develop dairy industry	Research, Technical assistance, projects
None stated	Development projects
None	Project implementation
Develop leadership and citizenship	Technical assistance, projects
Scholarship to horticulture student	Projects
None	Technical assistance, projects
Respect and protection of environment	Technical assistance, projects
By-products (meal from mixed offal)	Projects
Conservation	Research, Technical assistance, projects
None stated	Technical assistance

Table 9 (continued) Part D

Kinds of Support	Fund Sources	Area Served
Loans, in-kind services	Govt grants,contracts contributions	Puerto Rico only
Loans, materials, in-kind services	Loan interest, contracts other investment income	Puerto Rico only
In-kind services	Private contributions	Puerto Rico only
In-kind services	Private contributions	Puerto Rico only
In-kind services	Contracts, income from investments	Puerto Rico only
In-kind services	Member contributions	Puerto Rico only
In-kind services, materials	Private contributions	Puerto Rico only
Direct loans	Income from loans, investments	Puerto Rico only
Loans	Loan interest	Puerto Rico only
Loans, materials, loan guarantees	Govt appropriations, Public fund-raising	Puerto Rico only
Grant	Private contributions	Puerto Rico only
None stated	Private contributions	Puerto Rico only
In-kind services	Govt budget, contributions	Puerto Rico only
None	Sale of products	Puerto Rico only
Grants	Private contributions	Puerto Rico only
None stated	Private contributions	Puerto Rico only

Table 9 (continued) Part E

Research Clients	TechAssist Clients	Project Clients
Individuals, coops	Ind, coops, public agencies,educ inst	Individuals
Cooperative	Individuals	Individuals
None	Individuals	None
Private comnpanies	Private companies	Private companies
Individual contract	General public	In-house
None	Cooperatives	None
Individuals, companies, public agencies	Individuals, companies, public agencies	Indiv, companies public agencies
None	None	Individuals, cooperatives
None	None	Indiv, coops, companies
None	Individuals, educational institutions	Educational institutions
None	None	Individual
None	Individuals, NPOs ed inst, public ag	NPOs, ed inst
educational inst	Ind, NPOs, educ inst, public agencies	None
None	None	None
None	Educational inst, public agencies	None
None	Individuals	None

Table 9 (continued) Part F

Summary of Past Year Program

Develop tropical fruits as alternative crop, technical assistance for food processing and marketing, assist community organization

Manage coop assets, operate farm credit and supply services for members, interact with USDA Commodity Credit Corporation

Monthly meetings; field trips

Conduct conferences and studies, promote commercial interchange

Restoration of 2 historic sites, reforestation, research in historic coffee and sugar production, educational programs, land acquisition

Educational program for members includes renewable resource conservation and development

Improve milk quality; marketing development for milk; advertising cost studies

Provided farm credit to individuals and cooperative groups

Farm credit amounting to $30 million during 1985

Establish leadership and citizenship development activities; promote and develop new agricultural projects

Meetings, fund raising activities, scolarship award

Annual Tropiflora show; monthly meetings; landscape project for public site; 3 field trips

Operate animal shelter, provide animal vaccination and neutering services, provide humane education program

Produced and sold 34 million pounds of dressed poultry

Monthly lectures, field trips and newsletters, organized six special interest groups

Represent farm interests before the Legislature, reorganized by agricultural sector, organize annual meeting

Table 9 (continued) Part G

Major Role	Major Constraints
Develop alternatives to improve rural socio-economic conditions	Funding limitations, lack of govt interest and support, imported foods
Develop alternatives to tobacco for member farmers, improve coop services	Coordination with other coop groups. lack of public interest in coops
Education	Fiscal resources
Promote private agricultural activity	None stated
Set example by acquiring and managing critical/historic/scenic lands	Funding limitations, lack of local incentives for contributions
None stated	None stated
None stated	None stated
Provide farm credit at lowest possible interest rates	None
Provide credit for farmers	None stated
Promote development and management of renewable resources by youth	Lack of active promotion
Improve urban area	Funding limitations
Education	Lack of government aid
Public education concerning quality of life and natural resources	Funding limitations, public apathy and ignorance
Expand market for fresh poultry	Competition from mainland
Public education	Developing a dedicated and expanding "team" of members
Promote stable, efficient agriculture	Funding limitations, lack of clear public agriculture policy

Table 9 (continued) Part H

Major Opportunities	Potential Impacts
Improve coordination among interested parties, drop in value of dollar	More rural jobs, income; improved education opportunity, alternatives
Expand services and facilities in areas related to agriculture	Improve rural economic conditions, agricultural productivity
None stated	None stated
None stated	None stated
Expand fund-raising,promote transfer of development rights	Protect additional critical areas of ecological or historic value
None stated	None stated
None stated	Increase production and consumption of local dairy products
Improve agricultural economy	None stated
More aggressive marketing program	Provide credit for additional farmers
Expand promotional activities	Greater involvement of youth in FFA renewable resources projects
Expand activities,	Generate public interest in environmental beauty
Establish arboretum	Public education
Expand activities	Improve quality of life, reduce animal and child abuse
Capability to double production if market can absorb it	Create jobs; increase island's self-sufficiency in poultry
Develop a nature center, expand field programs, ties to youth groups	Gradual development of sound basis for informed public opinion
Promote activity at local level	Expand services to farmers

Table 9 (continued) Page 2

Organization Name	Location
Puerto Rico Green Thumb	Minillas Govt Ctr, Santurce, P R
Puerto Rico Improvement Fund "Fondo de Mejoramiento"	Cond. Torre Alta, Hato Rey, P R
Puerto Rico Manufacturers Association	Midtown Bldg, Hato Rey, P R
Puerto Rico Production Credit Association	Domenech 213, Hato Rey, P R
Puerto Rico Products Association	O'Neill 207, Hato Rey, P R
To-Ricos, Inc	Aibonito, P R
Tropic Ventures	Guayama and San Juan, P R
Virgin Islands Conservation Society	No office

Table 9 (continued) Page 2, Part A

Mail Address	Area Code/ Telephone
PO Box 41231, Santurce, P R 00940	809 727.8035
GPO Box 4740, San Juan, P R 00936	809 759.8366
PO Box 2410, Hato Rey, P R 00919	809 759.9445
GPO Box 3m649, San Juan, P R 00936	809 753.0548
GPO Box 3631, San Juan, P R 00936	809 753.8484
PO Box 646, Aibonito, P R	809 735.8061
PO Box 231, San Juan, P R 00902	809 721.3148
PO Box 12379, St. Thomas, USVI 00801	None

Table 9 (continued) Page 2, Part B

Name and Title of Director	Year Established	Primary Area of Interest
Eladia Ramis, State Director	1972	Training elderly persons in employable skills
Arq. Gabriel Ferrer-Amador, Executive Director	1971	Promote human and environmental betterment in Puerto Rico
Hector Jimenez Juarbe, Executive Vice Pre	1928	Promote trade and services
Angel A. Portalatin, Executive Director	1934	Credit to farmers for agricultural operations
Oscar Prieto, Executive Director	Not given	Management service for minority entrepreneurs
Joaquin Rodriguez	1957	Poultry raising/processing
John W. Druitt	1982	Beneficial use of tropic forests without ecologic damage
None identified	1966	Educational programs, direct legal action to promote conservation

Table 9 (continued) Page 2, Part C

Secondary Area of Interest	Types of Activity
Environmental conservation	Projects
Environmental and cultural education	Research, technical assistance, projects
None stated	Technical assistance, projects
None stated	Projects
None stated	Technical assistance projects
Egg hatchery	Research, technical assistance
Gather ecological data on rain forests	Research, technical assistance, projects
None stated	None identified

Table 9 (continued) Page 2, Part D

Kinds of Support	Fund Sources	Area Sereved
In-kind services	Govt budget	Puerto Rico only
In-kind services, tourist guidance	Private cont, public solicitation, contracts	Puerto Rico only
In-kind services, materials	Private contributions	Puerto Rico only
Direct loans	Bonds	Puerto Rico only
In-kind services Consulting	Contracts	Puerto Rico only
None	Sale of products	Puerto Rico only
Grants, in-kind services, joint ventures	Private contributions	Puerto Rico only
In-kind services	Private contributions; public fund-raising	Virgin Islands only

Table 9 (continued) Page 2, Part E

Research Clients	Tech Assist Clients	Project Clients
None	None	Individuals
None	Indiv, NPOs, educ inst, public agencies	Individuals public agencies
None	All sectors	None
None	None	Individuals
None	Individuals, companies	None
None	None	None
All sectors	Companies	Companies
None	None	Individuals

Table 9 (continued) Page 2, Part F

Summary of Past Year's Program

Promote activity of elder persons in food production, forestry, parks and grounds maintenance, home repair, home health care

Monthly newsletter, educational tours of historical, cultural and natural areas, hike along panoramic route

Organized environmental affairs committee, held two environmental seminars; contributed to north coast aquifer study

Direct loans for operating farms totalling $15 million

Management services and technical assistance to 600 minority entrepreneurs in the San Juan-Caguas metropolitan areas

Increased production of pre-packaged products

Planting program to enhance secondary forests; constructed needed infrastructure; opened San Juan center

Published newsletters; engaged in 3 lawsuits on enforcement of environmental statutes; testified in hearings; field trips

Table 9 (continued)   Page 2, Part G

Major Role	Major Constraints
Use skills of older workers for renewable and other resources	Funding limitations reduce number of persons who can enroll in program
Promote awareness of private citizens and government agencies	Funding limitations, lack of trained personnel, lack of govt interest
Monitor legislation and regulations that affect industry	Pre-treatment requirements for wastes; Non-delegation of EPA authority
No direct role	Competition from other lenders
Not directly	None stated
None stated	Competition from imports
Demonstrate global interdependence	Lack of public interest and government cooperation
Provide a moderate, informed voice to advocate environmental concerns	Public apathy; political incompetence

Table 9 (continued) Page 2, Part H

Major Opportunities	Potential Impacts
Expand scope of program activities and number of project locations	Provide employment for additional numbers of elderly persons
Obtain funds, expand staff, develop environmental projects	Reach more people, expand ppublic awareness; assist community projects
None stated	None stated
Expand loan program to other farm-related activities	Permit more farmers to participate in programs
Programs for agriculture and fisheries	Diversified economic activity with jobs for young people
Innovative product lines	Increased employment
Expand program to other areas of region; gather additional data	Improve regional economy; expand public awareness of ecology
Develop public environmental ethic and tradition of civic problem solving	None stated

Table 10. TABULATION OF KINDS OF CONSTRAINTS IDENTIFIED

Constraint	Int	U.S.	Ins.	Acad.	NGO	Total
Total Number Responding	9	26	29	10	24	98
No constraints identified	1	2	7	1	-	11
Total reporting constraints	8	24	22	9	24	87
Limited funding or cutbacks	4	17	13	8	8	50
Personnel, lack of qualified staff	1	9	6	3	2	21
Lack of interest, apathy, ignorance	1	2	-	2	7	12
Lack of adequate data	-	2	2	3	-	7
Laxk of communication	1	3	-	-	2	6
Lack of appropriate infrastructure	-	1	4	-	-	5
Lack of coordination/cooperation	1	-	-	2	1	4
Limited client ability to match	-	3	1	-	-	4
Competition from external sources	-	-	-	-	4	4
Rapid development pressure	-	-	3	-	-	3
Lack of training opportunity	1	2	-	-	-	3
Economic situation, finances	-	-	2	-	-	2
Lack of institutional base	1	-	1	-	-	2
Lack of adequate public policy	-	-	1	-	1	2
Bureaucratic delays/incompetence	-	-	1	-	1	2
All-volunteer staff	1	-	-	-	-	1
Replacement of retiring scientists	-	1	-	-	-	1
Limited client ability to share costs	-	1	-	-	-	1
Legislative ceiling on local program	-	1	-	-	-	1
National/local priority conflicts	-	1	-	-	-	1
Lack of adequate zoning	-	-	1	-	-	1
Squatters	-	-	1	-	-	1
Lack of timely reporting	-	-	1	-	-	1
Lack of incentives for contributors	-	-	-	-	1	1
Number of constraints reported	11	41	38	18	28	135

Note: Several respondents noted more than one constraint

Source: Survey responses, consultant opinions

Table 11. TABULATION OF TYPES OF OPPORTUNITIES LISTED

Opportunity	Int	U.S.	Ins.	Acad.	NGO	Total
Total Number Responding	9	26	29	11	24	99
No opportunities identified	1	1	9	2	7	20
Total reporting opportunities	8	25	20	9	17	79
Increased funding	2	9	8	3	1	23
Recruit qualified additional staff	1	10	6	-	1	18
Expand activities, programs, facilities	2	-	-	1	11	14
Improve collaboration/coordination	3	2	-	4	2	11
Improve production/marketing	-	-	2	-	4	6
Add facilities/infrastructure	1	3	1	-	1	6
Increase public awareness, support	-	-	1	2	2	5
Institutionalize programs	-	1	2	1	-	4
Soil/water conservation, reforestation	-	1	1	-	-	2
Axquire sensitive lands	-	1	1	-	-	2
Generate political understanding, support	-	1	-	-	1	2
Develop priorities	-	2	-	-	-	2
Provide technical training, assistance	-	-	2	-	-	2
Expanded, accelerated research	-	1	-	-	-	1
Expand membership	1	-	-	-	-	1
Promote small projects	1	-	-	-	-	1
Resolve fishery problems	-	1	-	-	-	1
Improve hazard preparation	-	1	-	-	-	1
Improve laws	-	-	1	-	-	1
Make effective use of resources	-	-	1	-	-	1
Improve economic incentives	-	-	1	-	-	1
Delegate Federal programs	-	-	1	-	-	1
Separate local programs from Federal	-	-	1	-	-	1
Enact appropriate zoning	-	-	1	-	-	1
Create new academic programs	-	-	-	1	-	1
Devaluate dollar	-	-	-	-	1	1
Promote development rights transfer	-	-	-	-	1	1
Number of opportunities reported	11	33	30	12	25	111

Note: Several respondents noted more than one opportunity.

Source: Survey responses and consultant opinions

Table 12

LIST OF AGENCIES AND ORGANIZATIONS THAT FAILED TO RESPOND TO SURVEY QUESTIONNAIRES OR WHOSE QUESTIONNAIRE WAS RETURNED AS NOT DELIVERABLE

as of 30 April 1986

Organization Name, Address, Director, Telephone

INTERNATIONAL AND REGIONAL ORGANIZATIONS

Regional Organizations - United States

Southeastern Association of Fish and Wildlife Agencies
c/o Department of Wildlife Conservation
P.O. Box 451
Jackson, Mississipi 39205
Lon Strong, Executive Director
(601) 961 5315

UNITED STATES FEDERAL AGENCIES AND ORGANIZATIONS

Operating in both Puerto Rico and the Virgin Islands

Department of Commerce
Economic Development Administration
620 Degetau Federal Office Building
Hato Rey, Puerto Rico 00918
Arturo Febry, Representative for PR/VI
(809) 753 4436

Department of Health and Human Services
Food and Drug Administration
P.O. Box 4427
San Juan, Puerto Rico 00905
Dr. Lynn Campbell, District Director
(809) 723 4848

Operating Only in Puerto Rico

Department of Agriculture
Agricultural Marketing Service, Federal/State
Inspection Service, Fruit and Vegetable Quality Division:
Fresh Products Inspection Branch
Processed Products Inspection Branch
P.O. Box 9112
Santurce, Puerto Rico 00908
Charles Malavet, Superviser
(809) 783 2230

United States Federal Agencies and Organizations (continued)

Operating only in the U.S. Virgin Islands

Department of the Interior
National Park Service
Buck Island Reef National Monument
Christiansted Historic Site
Fort Christiansvaern
Christiansted, St Croix, USVI 00820
Tom Bradley, Superintendent
(809) 773 1460

INSULAR GOVERNMENT - PUERTO RICO

LEGISLATIVE ASSEMBLY

House Committee on Agriculture
Capitol Building
San Juan, Puerto Rico 00901
Hon. Humberto Zayas Chardon, Chairman
(809) 722 4296

EXECUTIVE AGENCIES

Department of Agriculture
Agricultural Services Administration
P.O. Box 9200
Santurce, Puerto Rico 00908
Cruz M. Rodriguez, Administrator
(809) 723 8534

Milk Industry Regulating Office
P.O. Box 10163
Santurce, Puerto Rico 00908
Luis Fullana Morales, Director
(809) 756 5945

Department of Commerce
PO Box S-4275
San Juan, PR 00905
Jorge L. Aquino-Nunez, Secretary
(809) 723 3290

Insular Government - Puerto Rico (continued)

Department of Health
Environmental Health Secretariat
G.P.O. Box 70184
San Juan, Puerto Rico 00936
Ricardo J. Mayoral, Assistant Secretary
(809) 767 6013

Cooperative Development Administration
P.O. Box 21408
Rio Piedras, Puerto Rico 00928
Cesar R. Estrada, Administrator
(809) 751 6512

PUBLIC AUTHORITIES AND CORPORATIONS

Dairy Industry Corporation (INDULAC)
P.O.Box 10163
Santurce, Puerto Rico 00908
Luis Fullana Morales, Executive Director
(809) 756 5945

Recreation Development Company
Zoological Garden (Mayaguez)
P.O.Box 3207
San Juan, Puerto Rico 00904
Eugenio Rojas Nater, Manager
(809) 722 4458

INSULAR GOVERNMENT - U.S. VIRGIN ISLANDS

Department of Conservation and Cultural Affairs
Central Office
P.O. Box 4330
St. Thomas, USVI 00801
Angel L. LeBron, Commissioner
(809) 774 3320

Bureau of Environmental Enforcement
P.O Box 4330, Charlotte Amalie
St, Thomas, U.S. Virgin Islands 00801

Bureau of Fish and Wildlife
101 Estate Nazareth
St. Thomas, U.S. Virgin Islands 00802

Insular Government - U.S. Virgin Islands (continued)

Department of Conservation and Cultural Affairs (continued)

Division of Natural Resources Management
P.O.Box 4330, Charlotte Amalie
St. Thomas, U.S. Virgin Islands 00801

Department of Education

Environmental Education Program

ACADEMIC INSTITUTIONS - PUERTO RICO

University of Puerto Rico

College of Agricultural Sciences
Mayaguez, Puerto Rico 00708
(809) 834 4040

Department of Biology
Rio Piedras, Puerto Rico 00931
(809) 764 0000

Department of Biology
Mayaguez, Puerto Rico 00708
(809) 834 4040

Humacao University College
Station CUH
Humacao, Puerto Rico 00661
Dr. JoseR. Echevarria, Chancellor
(809) 852 2525

Regional College of the Mountains
P.O. Box 1449
Utuado, Puerto Rico 00761
Dr. Jaime E. Jordan-Molero, Director/Dean
(809) 894 2828

Interamerican University
Metropolitan Campus
San Juan, Puerto Rico
Dr. Ramon A. Cruz, President

ACADEMIC INSTITUTIONS - U.S. VIRGIN ISLANDS

College of the Virgin Islands

Agricultural Experiment Station
Route 2, P.O. Box 10051, Kingshill
St Croix, U.S. Virgin Islands 00850
Dr. Kenneth Green, Asst Director

Division of Science and Mathematics
Charlotte Amalie
St. Thomas, U.S. Virgin Islands 00801
Dr. LaVerne Ragster, Head
(809) 776 9200

Environmental Science Center
Charlotte Amalie
St. Thomas, U.S. Virgin Islands 00801
Dr. Michael Canoy, Director
(809) 776 9200

Marine Biology Program
Charlotte Amalie
St.Thomas, U.S. Virgin Islands 00801
Dr. William McLean, Leader
(809) 776 9200

St. Croix Campus
Rt 2, P.O. Box 10000, Kingshill
St Croix, U.S. Virgin Islands 00850
Dr. Mary Savage, Director

Fairleigh Dickinson University (New Jersey)

West Indies Laboratory
Teague Bay, Christiansted
St. Croix, U.S. Virgin Islands 00820
Dr. John Ogden, Director
(809) 773 3339

National Undersea Research Program
Dr. Susan Williams, Science Director

NON-GOVERNMENTAL ORGANIZATIONS - PUERTO RICO

Agricultural

Agricultural Cooperative Society
G.P.O.Box 4088
San Juan, Puerto Rico 00936
(809) 754 1550

Agronomists Association of P.R.
G.P.O. Box 5
San Juan, Puerto Rico 00936
Jose A. Berrios, President
(809) 753 7222

4-H Clubs
c/o Agricultural Extension Service
Call Box 21120
Rio Piedras, Puerto Rico 00927
Dr. Carmen Y. Carrasquillo, Director
(809) 765 8000

Natural Resources

Campers Association
G.P.O. Box 2893
San Juan, Puerto Rico 00936
(809) 721 2709

Eastern Fishermens Congress
P.O. Box 2411
Punta Santiago, Puerto Rico 00741
Jose Oquendo, President

Fishermen's Federation
c/o Sergio de Jesus Casillas
P.O. Box 89
Palmer, Puerto Rico 00721
(809) 887 3186

Fishermen's Federation of the East
P.O. Box 515
Fajardo, Puerto Rico 00740
Diego Mitchell, President

Hunter's Association
Cuenca G-6, El Remanso
Rio Piedras, Puerto Rico 00926
Mariano Acosta Grub, President

Table 12. Agencies and Organizations that Failed to Respond (cont) page 7

Non-Governmental Organizations - Puerto Rico (continued)

Hunter's Association of San Juan
AW-13 East Rio Turabo Street, Valle Verde
Bayamon, Puerto Rico 00619
Guillermo Lluch, President
(809) 795 0341

Hunter's Federation
P.O. Box 8969
Ponce, Puerto Rico 00731
Servando Berio, President
(809) 842 6291

Hunting Club of Arecibo
Barrio Islote
Arecibo, Puerto Rico 00612

Hunting Club of Gurabo
P.O. Box 839
Gurabo, Puerto Rico 00658

Hunting Club of Juana Diaz
P.O. Box 282
Juana Diaz, Puerto Rico 00665

Hunting Club of Palmer
P.O. Box 480
Palmer, Puerto Rico 00721

Institute of Ecotechnics
P.O. Box 231
San Juan, Puerto Rico 00902

Lake and Rivers Fishermen's Association
P.O. Box 2161
Hato Rey, Puerto Rico 00919
Rafael Arriaga, President

P.R. Association of Soil and Water Conservation Districts
Calle 5, G-4, Riverview
Bayamon, Puerto Rico 00619
Miguel Ocasio, President

Non-Governmental Organizations - Puerto Rico (continued)

P.R. Ornithological Society
P.O. Box 23163, University Station
Rio Piedras, Puerto Rico 00931
Jose Colon, Treasurer
(809) 761 7641

P.R. Speleological Society
P.O. Box 3174, 63th Infantry Station
Rio Piedras, Puerto Rico 00929

Wildlife Association (Asociacion Pro Vida Silvestre)
P.O. Box 325
Cabo Rojo, Puerto Rico 00623

General

P.R. Community Foundation
718 Banco Popular Center
Hato Rey, Puerto Rico 00919
Rafael Fabregas, President

NON-GOVERNMENTAL ORGANIZATIONS - U.S. VIRGIN ISLANDS

Coral World

Dyck Marine Science Center

St. Georges Village Botanical Garden
P.O. Box 338
Frederikstead
St Croix, U.S. Virgin Islands 00840

Virgin Islands Conservation District
Morningstar Hill, Star Route
Christiansted, St Croix, USVI 00820
William Newkirk, Acting Chairman

Virgin Islands Resources Management Cooperative
c/o Caroline Rogers
P.O. Box 7789, Charlotte Amalie
St. Thomas, U.S. Virgin Islands 00801
(809) 774 2050